THE BLACK RIFLE

Collector Grade

THE BLACK RIFLE

M16 RETROSPECTIVE

R. Blake Stevens • Edward C. Ezell

Edited by R. Blake Stevens

Collector Grade Publications
INCORPORATED

OTHER COLLECTOR GRADE BOOKS . . .

Backbone of the Wehrmacht — the German K98k Rifle, 1934 – 1945
(1991; Author's Revised Edition 1993) by Richard D Law

The Black Rifle — M16 Retrospective
(1987; Enhanced Edition 1992) by R Blake Stevens and Edward C Ezell

The Bren Gun Saga
(1986) by Thomas B Dugelby

The Browning High Power Automatic Pistol
(1984; Expanded Edition 1990) by R Blake Stevens

EM-2 Concept & Design — A Rifle Ahead of its Time
(1980) by Thomas B Dugelby

Death from Above — The German FG42 Paratroop Rifle
(1990) by Thomas B Dugelby and R Blake Stevens

The Devil's Paintbrush — Sir Hiram Maxim's Gun
(1989; Revised Edition 1993) by Dolf L Goldsmith

The FAL Rifle
1993 Classic Edition. Includes the entire three-volume *FAL Series* plus Index:
North American FALs (paper 1979; 10th Anniversary Hardcover Edition 1989) by R Blake Stevens
UK and Commonwealth FALs (paper 1980; 10th Anniversary Hardcover Edition 1989) by R Blake Stevens
The Metric FAL (paper 1981; 10th Anniversary Hardcover Edition 1989) by R Blake Stevens and Jean E Van Rutten
The FAL Series Index (1989) by Eino Sierpe and R Blake Stevens

The Grand Old Lady of No Man's Land—the Vickers Machinegun
(1994) by Dolf L Goldsmith

Modern Military Bullpup Rifles — the EM-2 Concept Comes of Age
(1984) by Thomas B Dugelby

The SPIW — The Deadliest Weapon that Never Was
(1984) by R Blake Stevens and Edward C Ezell

US Rifle M14 — From John Garand to the M21
(1983; reprinted 1988; Revised Edition 1991) by R Blake Stevens

WAR BABY! The US Caliber .30 Carbine
(1992) by Larry L Ruth

WAR BABY Comes Home — The US Carbine Volume II
(1993) by Larry L Ruth

ISBN 0-88935-115-5

Published by Collector Grade Publications Incorporated
PO Box 1046 Cobourg, Ontario Canada K9A 4W5

Enhanced Second Edition

Printed in Canada

10 9 8 7 6 5 4 3 2

ACKNOWLEDGEMENTS

The kind assistance of a number of individuals and institutions has greatly enhanced the quality and authority of this book.

James W. Alley, Cincinnati, Ohio

American Historical Foundation, Richmond, Virginia

MWO (ret) Ian J. Anderson, Diemaco, Inc.,
Kitchener, Ontario

Maxwell G. Atchisson, Doraville, Georgia

Col. George M. Chinn, USMC (ret), W.E.S.TECH Inc.,
Harrodsburg, Kentucky

Lt. Col. Francis B. Conway (ret), Las Cruces, New Mexico

William C. Davis Jr., Tioga Engineering Co. Inc.,
Wellsboro, Pennsylvania

Thomas B. Dugelby, Freelton, Ontario

Robert J. Dynes, Stoney Creek, Ontario

Capt. F. A. William Etter, CFB Trenton, Ontario

Charles R. Fagg, Kingston, Arkansas

Robert W. Faris, Yuma, Arizona

the late John (Jack) Fernlund, Saginaw, Michigan

James Gardner, Ernst Leitz (Canada) Ltd., Midland, Ontario

Jean Huon, Clairefontaine-en-Yvelines, France

Jack Karnes, South El Monte, California

Steven Kemp, Richmond, Texas

Daniel W. Kent, Ann Arbor, Michigan

Peter G. Kokalis, Phoenix, Arizona

MGySgt. James W. Maddock, USMC

David J. Mathewson, North Haven, Connecticut

Contributions, many indispensable, are hereby acknowledged with gratitude from the following:

Jacques S. Michault, Sidem International, Brussels, Belgium

Bob Miller, Houston, Texas

[Editor's note: Bob Miller lives in Houston, and has kindly been the source of a number of very interesting illustrations. As can be seen, Bob is a dedicated collector of M16 rifles, accessories and memorabilia, and those who share a mutual interest in such items might wish to contact him directly at PO Box 1343, Bellaire, TX 77401 USA.
PS: Bob says so many people now call him Sweet ol' Bob that most just use the initials.]

John M. Miller, Marietta, Ohio

James Mongello, Arminex Ltd., Scottsdale, Arizona

Daniel D. Musgrave, Cabin John, Maryland

Will Piznak, Huguenot, New York

Q. A. D. (Ord) Pattern Room, Enfield, Middlesex, England

Bucky Raper, Imperial Schrade Corp., Providence,
Rhode Island

Alain Renard, Fabrique Nationale Herstal, Belgium

Joseph B. Roberts Jr., National Rifle Association,
Washington, D.C.

Robert E. Roy, Colt Firearms Division, Hartford, Connecticut

Larry L. Ruth, Walworth, New York

Lee Rutledge, Riverside, California

J. Nicholas Russo, Iowa City, Iowa

Small Arms Replacement Project (SARP), Ottawa, Ontario:
-Lt. Col. R. D. Herbert
-Capt. M. Gagné

Ian Skennerton, Margate, Australia

Neal Smith, Mentor, Ohio

Robert E. Snodgrass, Picatinny Arsenal, Dover, New Jersey

Springfield Armory National Historic Site,
Springfield, Massachusetts

L. James Sullivan, ArmaLite Inc., Costa Mesa, California

Richard E. Swan, A.R.M.S. Inc.,
West Bridgewater, Massachusetts

Donald G. Thomas, Marietta, Georgia

Victor G. Tuff, Blyth, Northumberland, England

USMC Joint Public Affairs Office,
Camp Lejeune, North Carolina

John H. Williams, East Hartford, Connecticut

Herbert J. Woodend, West Cheshunt, Herts, England

Ed Zalewa, Stafford Springs, Connecticut

ABOUT THE AUTHORS

R. Blake Stevens is the founder and President of Collector Grade Publications Incorporated, and to date the author of eight published books on modern military small arms. Mr. Stevens lives and works in Toronto.

Edward C. Ezell, Ph.D., is the Curator/Supervisor of the Division of Armed Forces History, National Museum of American History, Smithsonian Institution, Washington, D.C. As well as contributing many major articles on weapons and forces history to a number of prestigious periodicals, Dr. Ezell is the current editor of perhaps the world's most famous gun book, *Small Arms of the World*.

TABLE OF CONTENTS

FOREWORD

Towards the Truth about the M16

For several hundred years the basic military battle implement has been the rifle, at once a powerful symbol of a nation's might, its maker's skill, and its user's consequent chances of survival. Ideally, the best of rifles win their own victories in combat, becoming ever more the very core of hallowed army tradition. Generally speaking, while Ordnance research in a well-run modern army is never completed, the more successful a rifle in design and application the longer its "life", and the greater the opposition to its change or replacement.

At the time of this writing, the 5.56mm NATO M16A2 rifle is heir to worldwide acceptance after a quarter-century of US service, longer than any other US rifle in this century except the 1903 bolt-action Springfield. Throughout this period however, far from a history of calm acceptance, the M16 has sparked a curious and constant controversy: curious in that everyone has an opinion and defends it with great vigor, whether pro *or* con; and constant in the veritable flood of expert pronouncements, from a remarkable variety of sources, which flows unabated from the popular press.

One might suppose that within these arguments and reams of paper would repose the *truth* about the M16: how it grew, and why; what it is, and what it is not. Paradoxically, such is not the case: even the ***basic concepts*** embodied in this most controversial of weapons are often misapprehended, still popularly described in hand-me-down versions of ArmaLite's original ad-agency hype. In addition the ***military development*** of the M16, as we shall herein discover, has so far remained a story barely half-told. Outrageous untruths become more like "gospel" with each retelling in this atmosphere of misinformation, to the point where the ***true*** story of the Black Rifle, as it emerges for the first time in these pages, will quite likely surprise most readers.

Surprised or not, we hope you enjoy the experience.

R. Blake Stevens

April 24, 1987

1. An early British EM-2, made at Enfield Arsenal and used in the first NATO standardization trials at Fort Benning and Aberdeen Proving Ground in 1950. Caliber .280/30 (7x43mm); serial no. 14. *QAD (Ord) Pattern Room*

2. An early "Lightweight Automatic Rifle" from Fabrique Nationale of Belgium, shown with a rare array of proposed accessories. Also used at Fort Benning and Aberdeen in 1950. Caliber .280/30. *QAD (Ord) Pattern Room*

PART I - THE INNOCENCE OF YOUTH

INTRODUCTION

3. The US Ordnance-sponsored T25 rifle shown during an Arctic test, launching grenades. Chambered for various developmental versions of the US .30 "T65" cartridge (7.62x47-through-51mm). The Harvey-designed, rear-locking T25 was the US entry in the 1950 trials. US Army photo

Three important happenings set the stage for our tale, beginning with the famous international (American, British, Belgian and Canadian) rifle and ammunition standardization trials of the fifties. These convened in the United States in the summer of 1950, at Fort Benning and Aberdeen Proving Ground, under the watchful eye of the chief of US Army Ordnance R&D, Col. René R. Studler. Here the unorthodox EM-2 "bullpup" and the forerunner of the FN FAL, both in caliber .280/30 (7x43mm), were first presented for trial by the British Armament Design Establishment (ADE) and Belgium's Fabrique Nationale d'Armes de Guerre (FN). The American entry was the T25, the proud first fruit of Col. Studler's pet .30 caliber Light Rifle project. The T25 was chambered for the developmental US "T65" cartridge, which although touted as a genuine advance was in reality a pragmatic compromise with Army traditionalists who saw nothing wrong with the round which had won World War II. True, the finalized 7.62x51mm T65E3 was .55" shorter than the 7.62x63mm .30M2, but it was also fatter at the shoulder, and consequently somewhat harder to feed and extract. Ballistically, the two were substantially the same.

Meanwhile in Britain, the maxim that the power of the cartridge is *the* determining factor in any rifle/ammunition system had been taken to heart by the designers of the comparatively underpowered .280/30. Consequently, the two "foreign" entries in the 1950 trials produced significantly lower recoil energy levels (and therefore improved controllability and troop acceptability) while still maintaining what the British insisted was acceptable lethality at all practical combat ranges. By

4. Actual-size compendium of UK cartridge development, 1948-1953. From left: 1. the short-lived .270 (7x46mm) early Kynoch manufacture, unheadstamped; 2. the UK trials .280/30 (7x43mm) with base compatible with the US "T65", resurrected in 1970 for UK trials and headstamped RG 70 IZ; 3. the UK 7x49mm "High Velocity", headstamped RG 52 7m/m H.V.; 4. the joint UK/Belgian/Canadian 7mm "Compromise" (7x51mm), headstamped DAC 52; 5. an early forerunner of the 7.62x51mm NATO, headstamped FN 52. Editor's collection

*5. From left: experimental military loading of the commercial .300 Savage case (Canadian contract for Frankford Arsenal) headstamped DOMINION .300 SAV; 2. the original "Case, Cartridge, Light Rifle" (7.62x47mm) loaded with a double-cannelured M2 ball bullet and headstamped FA 45; 3. the Frankford Arsenal FA-T1 (7.62x49mm) headstamped FA * 48; 4. the FA-T1E1 (7.62x49mm) headstamped FA 49. Editor's collection*

comparison, the T65 round produced 40% more muzzle energy than the .280/30. Not surprisingly, the T25/T65 rifle/ammunition combination produced the heaviest recoil and was the hardest to control on full-auto fire.

In any event, the versatile FN .280 rifle emerged the overall favorite at the 1950 trials. To Col. Studler this was an unwelcome fact which altered the direction of the US Light Rifle project, soon sealing the fate of the luckless T25 and its short-lived successor the T47. However, it had absolutely no effect on ballistics: US Ordnance remained firmly wedded to the concept of the full-power infantry cartridge.

Further trials over the next four years saw some very interesting British, Belgian and Canadian 7mm cartridge and rifle improvements, but through it all the adamant Americans would brook no lessening of the power and range criteria they had set. Finally, after a private, face-saving compromise of "we'll adopt your cartridge if you adopt our rifle" (which never came to be), the T65E3 became the standard rifle round for all of NATO in 1954. (This story is told in detail, from the points of view of the various participants, in Collector Grade's *FAL Series* and *US Rifle M14*.)

As regards our present study, however, these trials serve mainly to set the stage for subsequent conflict by illustrating the rock of conviction which stood behind the US full-power caliber .30 cartridge, against all comers.

Secondly, on a somewhat tamer front, 1950 saw the Remington Arms Company, Inc. of Bridgeport, Connecticut hailed enthusiastically by America's varmint hunters. In a successful attempt to plug what was correctly perceived as the marketable gap between the rimmed .22 Hornet and the semi-rimmed .220 Swift, Remington that year introduced the first commercial rimless centerfire varmint cartridge. Resembling a miniature .30-06, the new round was designed by Mr. Mike Walker of the Remington R&D section, and was called the .222 Remington. It was in fact a completely new cartridge from the base up, with case dimensions differing from any cartridge then in existence. Designed for varmint hunting inside a range of 250 yards, the flat-shooting .222 Remington propelled its 50-grain bullet at a muzzle velocity of 3,200 fps.

A Famous Historian's Valuable Service

Commentary On

INFANTRY OPERATIONS AND WEAPONS USAGE IN KOREA

WINTER OF 1950-51

by

S. L. A. Marshall

6. The cover of Brigadier S. L. A. Marshall's 1951 Korean report for the Operations Research Office (ORO), an extension of his celebrated World War II "combat critiques" which pulled no punches in describing "the behaviour of men in the use of weapons, the behaviour of weapons as men use them, and the use of information in augmenting fighting power."
Courtesy Office, Chief of Military History

PRO CON

ORO OPERATIONS RESEARCH OFFICE
The Johns Hopkins University
CHEVY CHASE, MARYLAND

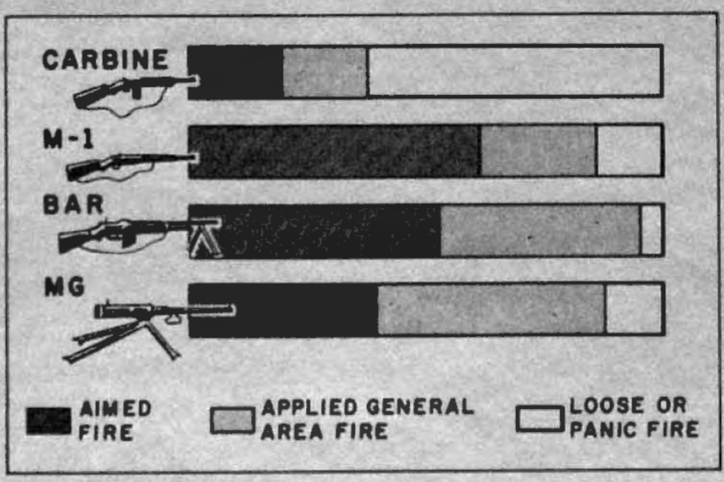
A third important thread of events began the seemingly impossible task of knitting the first two; military ammunition specifications and .22 caliber varmint hunting cartridges; inextricably together into a volatile and uneasy alliance. In 1950 the Korean war broke out, and Project "Doughboy" was created at the Army-sponsored Operations Research Office at Johns Hopkins University.

Formed in 1948 from elements of the wartime Center of Military History and the Office of Scientific Research and Development (OSRD), the civilian Operations Research Office (ORO) was the Army's official acknowledgement of "the growing role of scientific method" in planning for war in the atomic age. American troops fighting through the first bitter winter in Korea were meanwhile experiencing some very serious reversals. In Project "Doughboy", ORO's director Dr. Ellis A. Johnson sought documentation which might lead to some of the reasons why. The celebrated historian Brigadier General S.L.A. Marshall went to Korea and interviewed the troops, using the "post-combat critique technique" which he had pioneered with great success in the Pacific and European theaters of World War II. The result was the 142-page report ORO-R-13, *Commentary on Infantry Operations and Weapons Usage in Korea*, dated October 27, 1951. General Marshall focussed on American operations during the winter of 1950-51, which in his words "were of the period of maximum reverse and then recovery...[the]Eighth Army experienced its greatest and most prolonged stress; [and] the conditions peculiar to that period provide the best opportunity for the clear profiling of weapons, tactical and leadership values in combat.."

General Marshall found that the exigencies of climate and terrain made Korea different from either of the main Allied theaters of World War II, and made even tougher demands on the infantryman and his weapons:

> *..it can be said that in the nature of operations in Korea, the infantry weapons on our side, including mortars, grenades, and recoilless rifles, must be inflicting in excess of 50 percent of the enemy losses. This may be a unique situation in twentieth-century warfare...Recognition of the enemy, as he comes forward, is most likely to occur at some distance between 15 and 150 yards..too close and too late for practical and successful artillery intervention...The average effective infantry fire with weapons lighter than the machine gun was consistently less than 200 yards. In no instance was it established, in the operations brought under survey, that any significant move by enemy forces had been stopped and turned* by rifle and carbine fire alone *at ranges in excess of that figure.*

This graphically-described 200-yard limitation on *practical combat range* for infantry small arms fire is of primary interest to our story, for here at last was some sanction to "peek under the skirts" of the Army's range requirement: sanction for experiments that would have previously been denounced by US Ordnance as heretical.



7. Fig. 1 from S. L. A. Marshall's 1951 ORO report on weapons useage in Korea, graphically illustrating how ammunition was spent in "An Average Perimeter Defense".

Chapter One

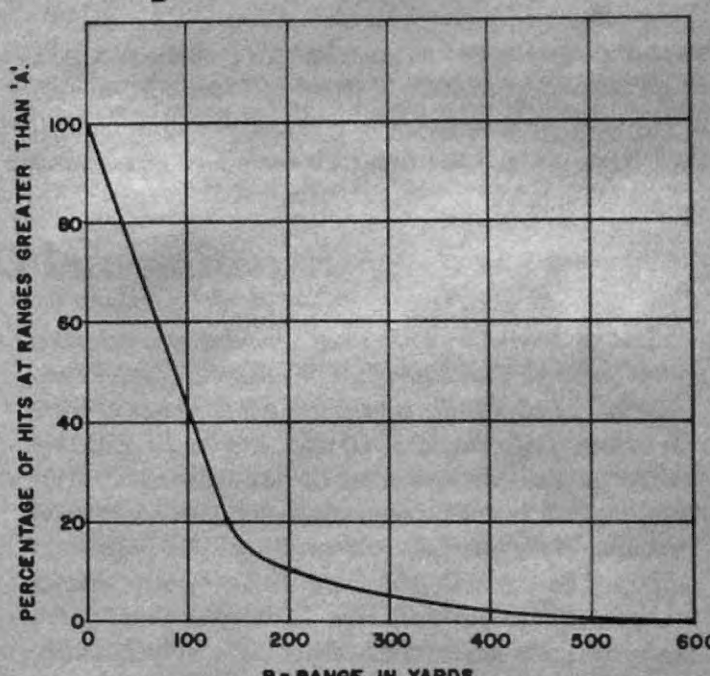
POSTWAR ORIGINS OF THE SMALL CALIBER, HIGH VELOCITY (SCHV) CONCEPT

The Hall Study

The first major postwar US study of rifle effectiveness was ordered by Col. Studler on November 28, 1950, almost before the smoke had cleared from the first international rifle trials. Tasked was Donald L. Hall, an engineer at Aberdeen's Ballistics Research Laboratories (BRL).

The findings of the Hall study were released in March of 1952 as BRL Memorandum Report no. 593, *An Effectiveness Study of the Infantry Rifle*. Based on the ongoing international trials, plus data contained in S. L. A. Marshall's *Commentary* and other data from Korea, the study took a decidedly unorthodox approach: it evolved on paper an experimental series of cartridges, *none of which* would satisfy the Army's range and penetration specifications as they then stood, and compared them to the effectiveness of the standard-issue .30M2 at ranges up to only 500 yards. This was treading perilously close to heresy, and Mr. Hall began his report with a hasty disclaimer:

> *This report was prepared without regard to present established military characteristics of the Army Field Forces, since the purpose of research is to provide basic data which may assist..in developing future requirements...In this study a family of weapons was considered. The caliber was varied from .30 to .21 and the weight of the charge was taken to be 1.0, 0.8, and 0.6-times the charge (53 grains) normally used in the present standard..ammunition...All bullets were considered to be homologous to [scaled-down replicas of] the cal. .30 ball M2 ammunition.*



8. *Fig. 8 from Donald L. Hall's March, 1952* Effectiveness Study of the Infantry Rifle, *entitled "Ballistic Experience in Korea". Extracted from wound ballistic survey by the US Medical Research and Development Board, November 1950 to May, 1951.*

Hall's calculations revealed that three somewhat interdependent factors governed the effectiveness of a rifle: the *probability* that the soldier would hit his target (dependent on range and muzzle velocity); the *ability* of the bullet to wound (a function of bullet mass, shape and striking velocity); and the *weight of rifle and ammunition*. As also quoted in *The SPIW - the Deadliest Weapon that Never Was*, Hall concluded:

In general it can be stated that if the combined weight of rifle and ammunition is fixed at 15 lbs., a man carrying the cal. .21 rifle would have an expectation of killing about 2 1/2 times as many targets as with the M1 rifle. The range at which this occurs depends on the amount of charge. The 0.6 charge is most effective at the short ranges because of the lighter ammunition. The 1.0 charge is most effective at the longer ranges because of its flatter trajectory.

The report ended with a reasoned plea that while the bulk of the study was only theoretical, the results were valid and worthy of serious consideration:

The final curves of relative overall expected number of kills show that rifles with heavy charges are preferable at the longer ranges, but those with the lighter charges are made preferable at the short ranges. It is beyond the scope of the present report to state which is the optimum rifle, for this would depend on the most probable combat range. An indication as to this range may be obtained from a wound ballistic report from Korea..the mean range is about 120 yards. From this it might be concluded that a rifle that is more effective at ranges up to 500 yards should be favored over one that is more effective at ranges greater than 500 yards.

Hall's last word was that soldiers carrying the smaller caliber, high velocity rifles in his theoretical family would be simply "more effective" than troops armed with the M1, in several ways. First and most importantly, they possessed "a greater single-shot kill probability". More hits and kills, therefore, would result when the *weight* of combined rifle and ammunition carried was equal, but when each carried an equal number of *rounds* the smaller calibers turned in a double advantage: more targets killed with a lighter load carried.

With the assistance of the Small Arms Section of Aberdeen's Development and Proof Services (D&PS), Hall had bolstered his theoretical conclusions with a most interesting series of actual firings, described in an addenda to his report as follows:

Experimental Data on a .220 Rifle

During the course of this study a number of conclusions were questioned because of the fact that the popular commercial .220 Swift rifle is generally felt to be less effective as a hunting rifle than a .30-06 rifle. Actually the .220 Swift cannot be reasonably compared with any of the rounds in the present study, because these rounds all involved scaled-down versions of the excellent caliber .30 ball M2 bullet, and therefore have considerably better ballistic characteristics than the inferior .220 Swift. The .220 Swift has a 48-grain, soft nose bullet in contrast to the 60-grain cal. .22 bullet, of the present [theoretical]study, that would be homologous to the cal. .30 ball M2.

Through the assistance of Col. Studler of the Ordnance Office, a rifle and 200 rounds of ammunition were acquired with a bullet shape that was nearly, but not quite homologous to the cal. .30 ball M2. The homologous cal. .22 bullet would be a 60-grain bullet having a 7.0 cal. radius tangent ogive and would be 0.625" long. The rounds received had a 6.0 cal. radius tangent ogive, were 0.76" long, and weighed 60 grains. As a result, the experimental ammunition had a ballistic coefficient of 0.13 (by actual measurements) as compared to 0.18 (calculated) for the homologous bullet..

The 200 rounds of cal. .220 ammunition were fired in a special Winchester rifle with a 10" twist to obtain ballistic, accuracy and penetration data...The results of these tests show..good accuracy and ballistic characteristics. If the bullet can be designed with a 7.0 caliber ogive, its ballistic characteristics will be considerably improved, and its effective range increased about 25%.

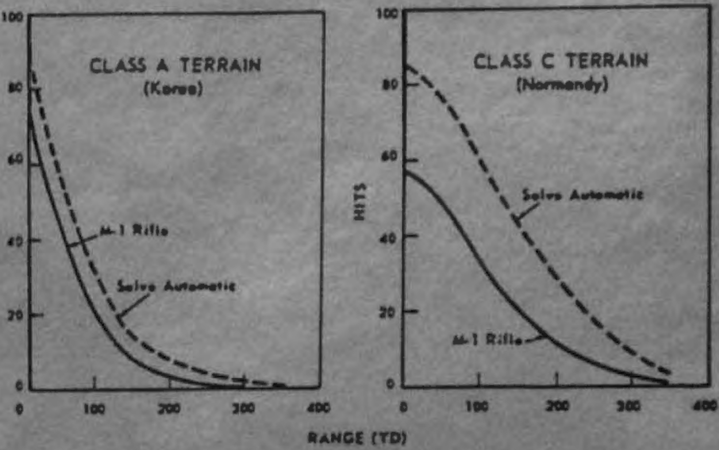
An interesting comparison is made in the ability to penetrate 10 gauge (.137") cold rolled sheet steel. The experimental cal. .220 round gave complete penetration at 500 yards (or 1,800 fps velocity) and partial penetration at 600 yards (or 1,600 fps). A cal. .30 ball M2 round will completely penetrate..at 625 yards (or 1,400 fps) and partially penetrate at 725 yards. If, however, the cal. .22 was made with a 7.0 caliber ogive (so as to give the same form factor as the cal. .30), the range at which the velocity would drop below 1,800 fps would be 700 yards, or approximately equal to the cal. .30..

..it could be concluded that for the same striking velocity, the cal. .220 is practically as effective as the cal. .30. This may be due to the fact that the cal. .220 appeared to tumble in..clay at all velocities considered...Furthermore..since the cal. .22 will have a higher striking velocity than the cal. .30, the severity of the wound for a given range should be much greater for the cal. .22 than for the cal. .30.

The Hitchman Report

In June of 1952, a scant three months after the appearance of the Hall study, ORO published its report no. ORO-T-160 entitled *Operational Requirements for an Infantry Hand Weapon*, by Norman A. Hitchman. This important document, already discussed at some length elsewhere in this series, gave new voice to Hall's politely implied paradox that the true parameters of improved rifle effectiveness lay, by order of the Office, Chief of Ordnance, "off limits" for study.

ORO had also been working on an exhaustive analysis of combat casualties in past wars. Hitchman correlated this information with S.L.A. Marshall's terrain/visibility and rifle-effectiveness studies of the bitter winter of the Eighth Army's "near total defeat" in Korea. He discovered that as things stood, the best and the worst US marksmen had about an equal chance of getting a hit in combat. Indeed, while taking fire from the enemy, a soldier could as easily be hit by a random shell fragment as by a bullet supposedly "aimed" at him; time and degree of exposure were the chief variables.



9. Fig. 8 from ORO's June, 1952 Hitchman report, comparing the relative hit effectiveness of the MI rifle with (theoretical) Salvo automatic fire for Class "A" (Korea) and Class "C" (Normandy) terrains. Note that the Salvo-type weapon offered considerably enhanced hit effectiveness at longer ranges, such as in the open terrain of western Europe, but neither weapon was as effective in Korea, where short-range combat was more the norm. Hitchman concluded that the quest for improved hit probability would best be served by "a small caliber lightweight weapon with controlled dispersion".

Hitchman's task was to come up with ways to improve the hit capability and hit severity of the "man-rifle combination".

He found that this would require nothing less than a re-examination of the *nature* of the combat rifle:

The ranges at which the rifle is used most frequently in battle and the ranges within which the greater fraction of man targets can be seen on the battlefield do not exceed 300 yards.

Within these important battle ranges, the marksmanship of even expert riflemen is satisfactory..only up to 100 yards; beyond 100 yards marksmanship declines sharply, reaching a low order at 300 yards.

Current models of fully automatic hand weapons.. are valueless from the standpoint of increasing the number of targets hit when aiming on separated man-size targets.

Certain of the costly high standards of accuracy observed in the manufacture of current rifles and ammunition can be relaxed without significant losses in overall hit effectiveness.

To create militarily acceptable..damage at common battle ranges, missiles of smaller caliber than the present standard .30 cal. can be used without loss in wounding effects and with substantial logistical and overall military gains.

The Hitchman report thus confirmed the Hall study's conclusion that a relatively "conventional" small caliber high velocity rifle offered a number of worthwhile advantages over the issue M1. Characteristically, this landmark ORO study went much further than had BRL:

To improve hit effectiveness at the ranges not covered satisfactorily..by men using the MI (100 to 300 yards), the adoption of a pattern-dispersion principle in the hand weapon could partly compensate for human aiming errors and thereby significantly increase the hits at ranges up to 300 yards.

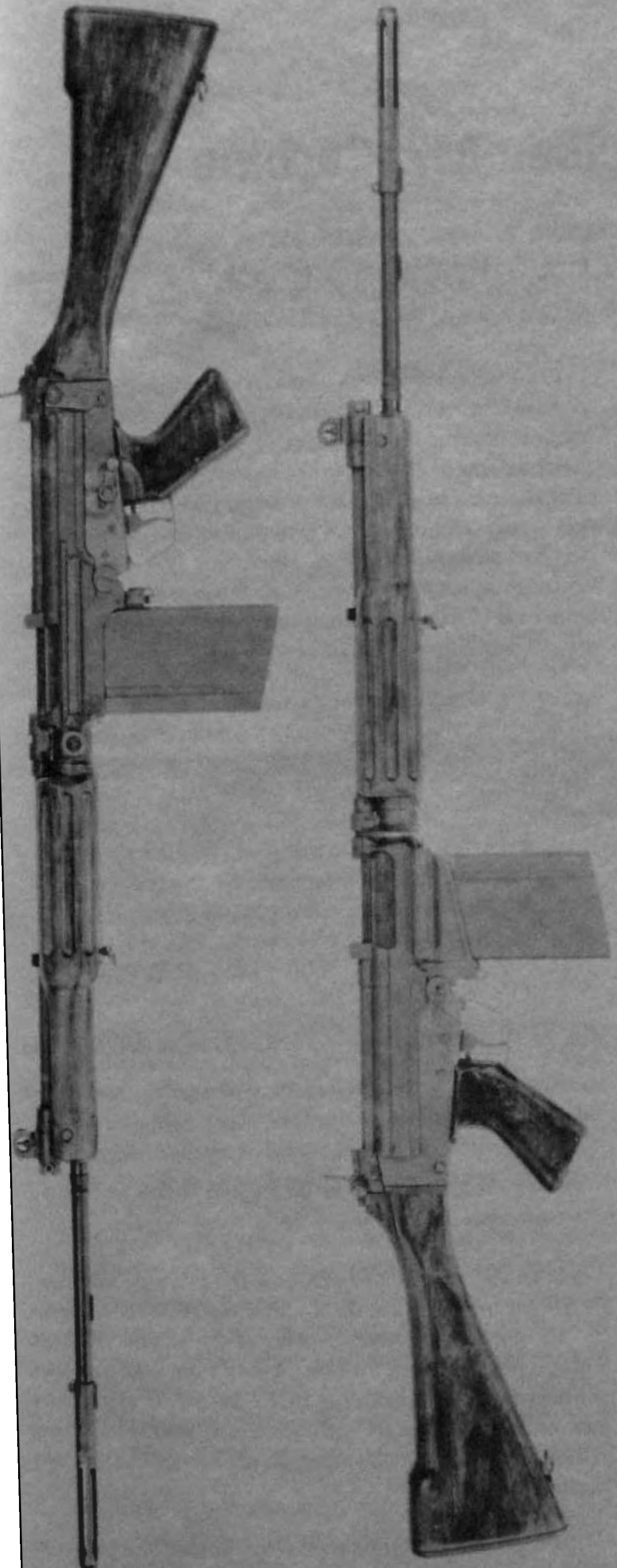
To meet the actual operational requirements *of a general purpose infantry hand weapon, many possibilities are open for designs which will give desirable dispersion patterns (and accompanying increases in hit probability) at the ranges of interest. Of the possible salvo or volley automatic designs, the small caliber, lightweight weapon with controlled dispersion characteristics appears to be a promising approach. (Low recoil of a small caliber weapon facilitates dispersion control.)*

10. An early version of the "Rifle, Lightweight, Cal. .30, T44", built at Springfield Armory on a lengthened M1 rifle receiver. The T44 succeeded the T25/T47 as Col. Studler's US contender in the 1952 international standardization trials. Note the range of proposed accessories, including the T47-type bayonet (no. 10) with latch in middle of handle.

Throughout its heady and contentious eleven-year history, the Operations Research Office's outspoken civilian staffers regularly paid far less heed to Army politics and hallowed tradition than could most employees of Ordnance Corps agencies like BRL. The Hitchman report was no exception, flying directly in the face of the Army's continued commitment to the full-power, selective fire .30 caliber rifle and cartridge.

All of Hitchman's many recommendations were subsequently explored in the important but essentially long-term Project SALVO (1953-1960). This fascinating multi-agency program contracted for the design and trial of a number of multiple-barrel Salvo rifles, multiple-bullet cartridges, and shotshells packed with small steel arrows or "flechettes". The story divides here, with one branch leading through Project SALVO to the ORO-sponsored development of the serial flechette - potentially the most lethal small arms projectile the world has ever known. This fantastic saga is fully documented in ***The SPIW - The Deadliest Weapon that Never Was***. The other path leads to the M16.

12. An ad for research personnel from the Operations Research Office (ORO). Reprinted from the November 4, 1960 issue of Science *magazine. Ironically, the booted, belted and goggled soldier-of-the-future carries a selective-fire 7.62mm M14 rifle, which the ORO-sponsored Hitchman report called "value-less..on separated man-sized targets".*



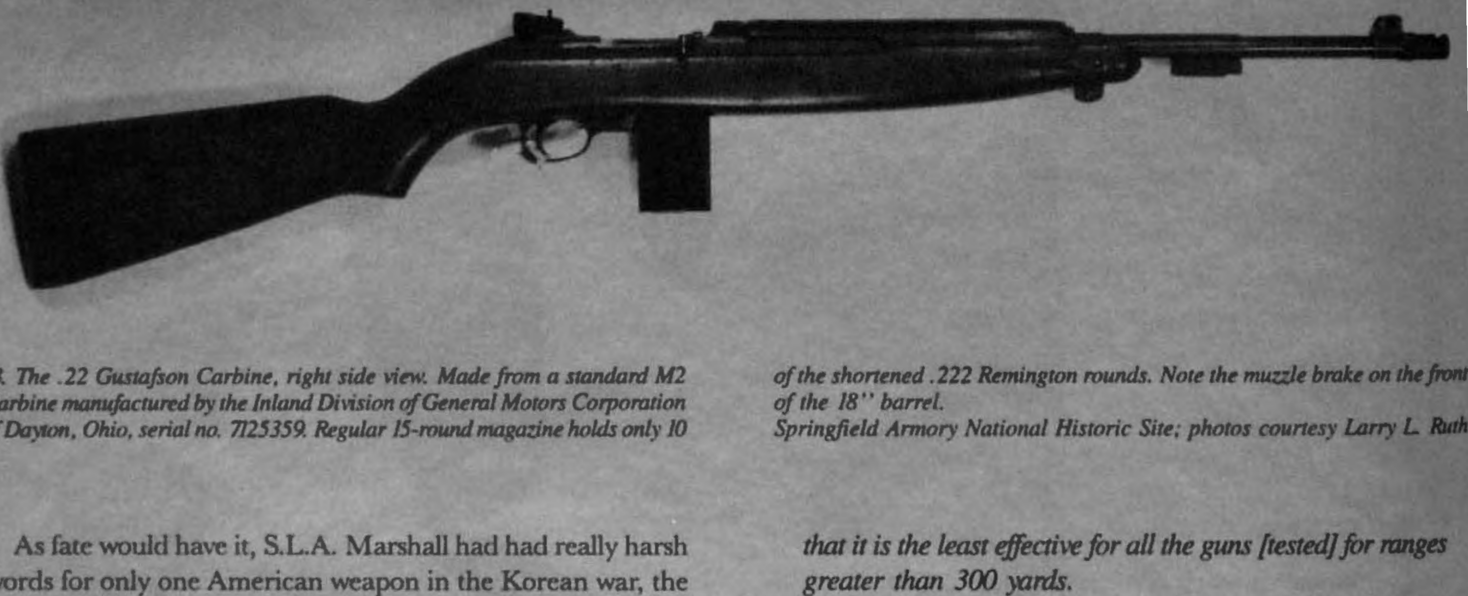
11. Prototype "Rifle, Lightweight, Cal. .30, FN" serial no. 38, the forerunner of the US T48, the choice of many as the successor to the US M1. Shown fitted with the US-designed flash hider, developed at Springfield Armory during the 1952 standardization trials.

Springfield Armory Ordnance Corps photo dated March 3, 1954

Aberdeen's .22 Caliber M2 Carbine

As noted, actual .220 high velocity firing trials had already substantiated Hall's theoretical effectiveness of the small caliber, high velocity (SCHV) concept. These firings had been performed by engineer William C. Davis Jr., at Aberdeen's Small Arms and Aircraft Weapons Section, and the chief of that division, Mr. G. A. Gustafson. While these ballistic experts were most impressed with the results they had obtained, not everyone found this avenue of endeavor so noteworthy. Col. Studler, chief arbiter of all R&D for small arms Ordnance, had allowed BRL only 200 of the necessary "near-homologous" bullets. The implication was clear: the main task at hand for all concerned was the successful development of a .30 caliber Light Rifle. Other, less important projects, funded with "leftovers", were necessarily much more long-term in nature. Plainly, further head-on effectiveness comparisons showing the .220 "homologous" bullet superior to the .30M2 would be unpopular, to say the least.

To the men at Aberdeen who were convinced of the SCHV's increased "man-rifle effectiveness", this was very disheartening. While it was true that, on paper, ORO's futuristic salvo-fired, pattern-dispersion ideas pushed hand weapon effectiveness to altogether new heights, at the intended pace of Project SALVO they would (and did) take a long time to develop. An SCHV rifle had already been fired, albeit only 200 times, and its effectiveness advantages were real. It seemed a shame not to pursue the SCHV idea, simply due to the "politics" surrounding the M1 rifle and its successors.



13. The .22 Gustafson Carbine, right side view. Made from a standard M2 Carbine manufactured by the Inland Division of General Motors Corporation of Dayton, Ohio, serial no. 7125359. Regular 15-round magazine holds only 10 of the shortened .222 Remington rounds. Note the muzzle brake on the front of the 18" barrel.
Springfield Armory National Historic Site; photos courtesy Larry L. Ruth

As fate would have it, S.L.A. Marshall had had really harsh words for only one American weapon in the Korean war, the caliber .30 (7.62x33mm) M2 Carbine. Indeed, the bitter reports of its chronic jamming in cold weather and its inability to stop an oncoming enemy stand out all the more starkly due to the high praise which officers and men alike heaped onto every other US arm, especially the M1 rifle. Politically, therefore, the Carbine's name was mud.

In the Hall study, the Carbine had not been included due to a lack of available wound-ballistics data, except to say that its single shot effectiveness was only about half that of the M1 rifle at 300 yards. Hall had concluded:

> *..the overall effectiveness [of the Carbine] is high at very close ranges but falls off rapidly for increasing ranges so that it is the least effective for all the guns [tested] for ranges greater than 300 yards.*

Mr. Gustafson reasoned that if the M1 rifle was "off limits" for further comparisons, the Carbine was beneath suspicion. In fact one of the touted benefits of the caliber .30 Light Rifle program was that the arm finally chosen would supplant not only the M1 rifle but the BAR, the M3A1 submachine gun and the Carbine as well. Therefore, who would object to a modest attempt to improve the effectiveness of the lowly Carbine?

The report of Gustafson's study, performed and produced virtually singlehandedly over a 17-month period, was released on 29 September, 1953. It makes fascinating reading, and is excerpted herewith:

Development and Proof Services
Aberdeen Proving Ground
Maryland

Design and Fabricate a High-Velocity Caliber .22 Cartridge, Modify a Standard M2 Carbine to Fire the Cartridge, Evaluate the Weapon-Ammunition Combination

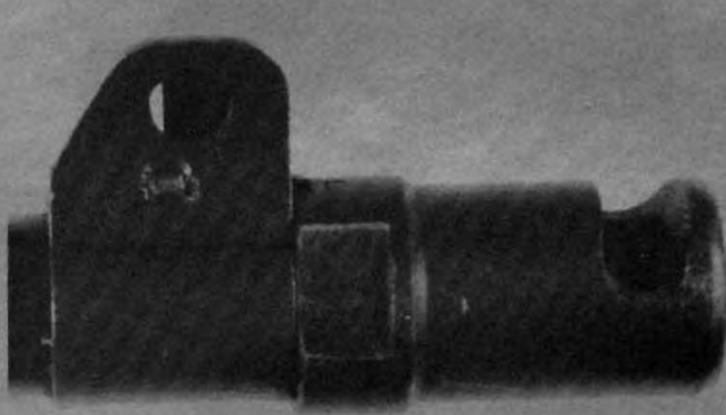
Dates of Program: 13 November 1952 to 21 August 1953

Object

The purpose of the program is to increase the effectiveness of the M2 Carbine, in both semi- and full-automatic fire, by adapting it to a high-velocity, small-caliber, cartridge.

Discussion

In April, 1952, Mr. T. F. Colleran, Director of Development and Proof Services, and Col. J. D. Armitage, Chief of Arms and Ammunition Division at Aberdeen Proving Ground, granted verbal approval to a project proposed by the Small Arms and Aircraft Weapons Branch to investigate the merit of small-caliber, high-velocity cartridges for use in rifles and Carbines. Col. R. R. Studler, Office Chief of Ordnance, ORDTS, also gave oral approval to the preliminary investigation with the understanding that a program would be authorized by his office if the cartridges proved promising in the early tests...[Program Authority granted by teletype no. ORD 12153, 2 June 1953].



14. Closeup of the muzzle brake on .22 Gustafson M2 Carbine serial no. 7125359.

Considerable delay was encountered in obtaining suitable barrel blanks and chambering reamers for making velocity and pressure barrels. In November, 1952, sketches of "Maximum Cartridge" and "Minimum Chamber" were made and the project was initiated in the Small Arms Branch gunsmith shop on a spare-time basis because of its low priority.

The caliber .30 Carbine has been regarded with considerable disfavor during the recent fighting in Korea, probably to some extent because it has been employed tactically as a rifle rather than as a replacement for the pistol. Perhaps this general misuse of the Carbine indicates that there is a real combat requirement for a weapon of the Carbine type. Battlefield reports indicate that poor functioning, accuracy and stopping power were charged against this weapon.

It was thought at this station that the complaints against the Carbine could be eliminated, in the most part, by furnishing a cartridge of high velocity, with resulting flat trajectory, and good accuracy to afford a high percentage of hits on a man-size target up to 300 yards. Past experience with privately-owned lightweight sporting rifles of small caliber and high velocity indicated that the 300-yard criterion for effective range could probably be met with respect to accuracy and trajectory, and that a good chance for improving terminal performance over that of the caliber .30 Carbine cartridge existed..

The poor reputation of the lightweight Carbine for burst-fire dispersion is well deserved. The relatively heavy bullet develops rather severe recoil momentum for burst-fire control, even at its low velocity. A compensator can contribute very little toward burst-fire stability because the ratio of mass of powder gases to bullet mass is small. [With] a lightweight, high-velocity cartridge,..the bullet muzzle energy can be about equal to the standard round, yet recoil momentum be considerably reduced. Also, the heavier powder charge required to give higher velocities affords more momentum which can be employed by a compensator to reduce muzzle movement and recoil.

Description of Materiel

The cartridge designed to fire in the modified M2 Carbine, and the standard caliber .30 Carbine round are compared below for physical properties:

Cartridge caliber	.30	.22
bullet wt (grains)	110	41
charge wt (grains)	13.5	18.0
total wt (grains)	193	145
case length (in)	1.295	1.320
overall length (in)	1.680	1.700
max diameter (in)	.357	.375

15. Closeup of the bolt face of .22 Carbine no. 7125359. Note the increased diameter of the cartridge seating area, necessitated by the larger base of the .222 Remington round.

A standard caliber .30, M2 Carbine was modified to fire the .22 cartridge by fitting and chambering a commercial caliber .22 barrel and machining the outside contour to that of the standard Carbine barrel. It was desired that the caliber .22 barrel have a bore diameter of .219 inch, a groove diameter of .224 inch, and rifling of one turn in 16 inches with uniform, right-hand twist; however the available blanks ..were slightly "tighter" than specified. Other modifications to the weapon consisted of modifying the bolt face to accommodate the larger cartridge case base and increasing the strength of the hammer spring. The muzzle was threaded to accommodate a compensator which was designed to minimize muzzle movement, both upwards and sidewise. It also reduced recoil in "muzzle brake" fashion by changing the direction of expending powder gases. A bipod from a Browning Automatic Rifle was modified to fit [both] Carbines in order to evaluate their long-range, burst-fire accuracy characteristics. The larger diameter..caliber .22 cartridge resulted in a reduction of magazine capacity from 15 rounds of caliber .30 to 10 rounds of caliber .22.

Dies for making the caliber .22 Carbine ammunition were made to fit a Pacific commercial-type hand loading press. Tools to perform the following operations were made: full-length resizing of cartridge case, reaming case neck, depriming case, repriming case, bullet seating. Crimping dies were not made because only un-cannelured commercial bullets were available. A pressure barrel was made to fit a Universal receiver. The velocity barrel of the Mann type was made by fitting a commercial caliber .22 barrel blank to a Springfield M1903 action and turning down the outside barrel contour to fit the recoiling v-slide of a Frankford Arsenal machine rest.

All of the machine work on the chambering reamers, cartridge loading dies, proof facility weapons and the test Carbine was done at the gunsmith shop at the Small Arms and Aircraft Weapons Branch. Cartridge cases were fabricated by shortening commercial .222 Remington cases to the desired length. All ammunition assembling was done at the loading room of the Small arms and Aircraft Weapons Branch.

Procedures

..Counter-type, electronic chronographs, employing lumiline (photoelectric) indicators, were used for all velocity measurements.

Peak chamber pressures were obtained by use of conventional-type, radial gauges with copper cylinders.

Ballistic data were obtained by firing through lumiline initiators at 28.5 and 78.5 feet and two make-circuit screens at 580 and 620 feet from the gun muzzle..

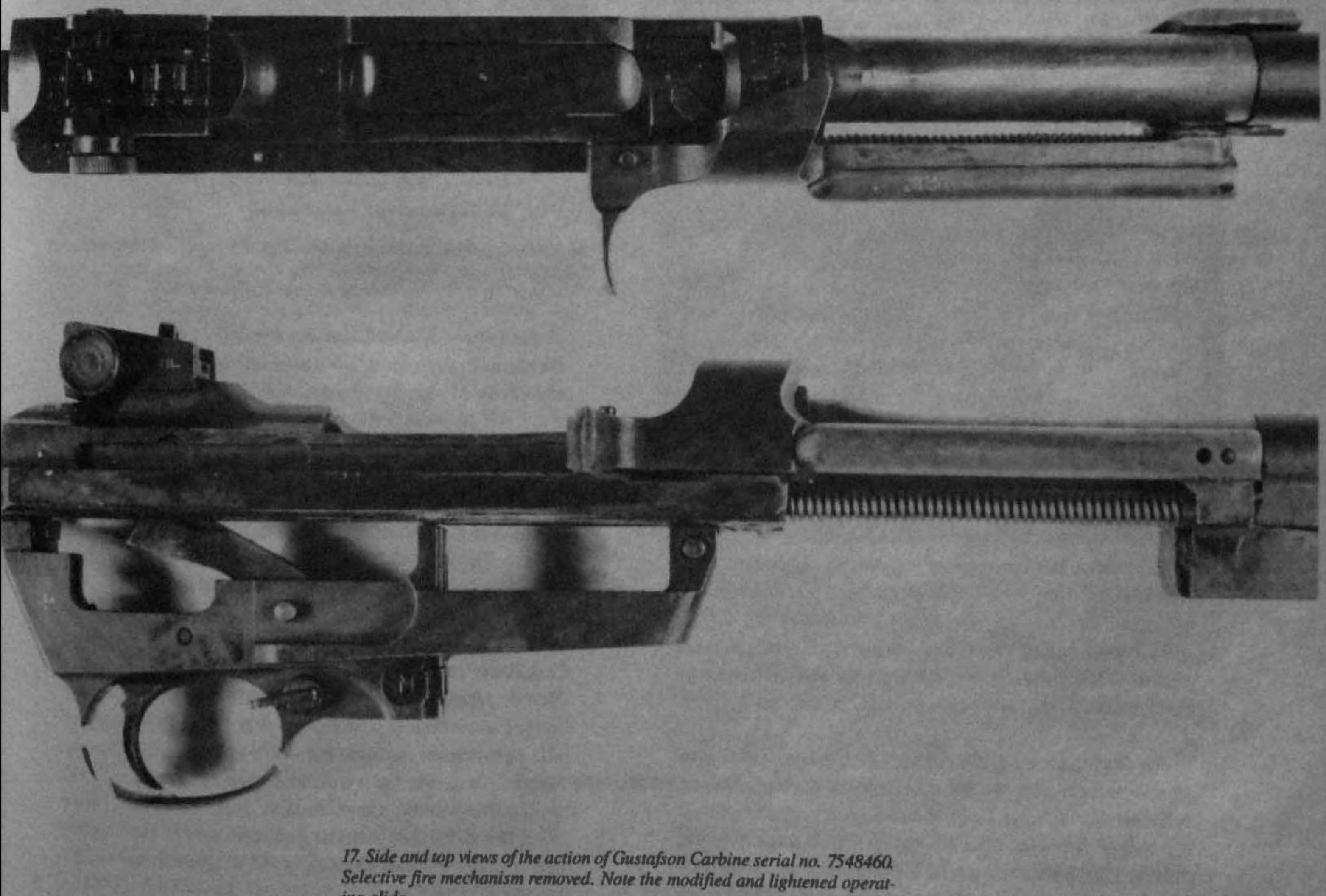
In establishing velocity-pressure relationships of various propellants, a maximum pressure of 42,000 psi was selected

16. Experimental .22 M2 Carbine, serial no. 7548460. Stock cut off at wrist and holes in forestock (ahead of magazine) for mounting in test fixture; steel tube attached to operating slide to facilitate measurement of component velocities; 24" .22 caliber barrel rifled 1 turn in 16" (with no front sight) chambered for the shortened .222 Remington round.

because this was considered the highest maximum average pressure that would be safe to use in the present Carbine mechanism. The highest velocity obtainable within this limit was desired.

The qualification course for the M1 rifle, Course B using the A target, was chosen rather than the course of fire for the Carbine, because preliminary trials of accuracy and trajectory indicated that the latter course of fire would be too "easy" to give a proper evaluation of the caliber .22 Carbine.

..Armor-piercing bullets were made by inserting hardened steel cores in the commercial-type bullets.



17. Side and top views of the action of Gustafson Carbine serial no. 7548460. Selective fire mechanism removed. Note the modified and lightened operating slide.

Observations

..The goal was to obtain at least 3,000 fps muzzle velocity without exceeding 42,000 psi maximum average breech pressure. This objective, while attained, was only slightly exceeded..

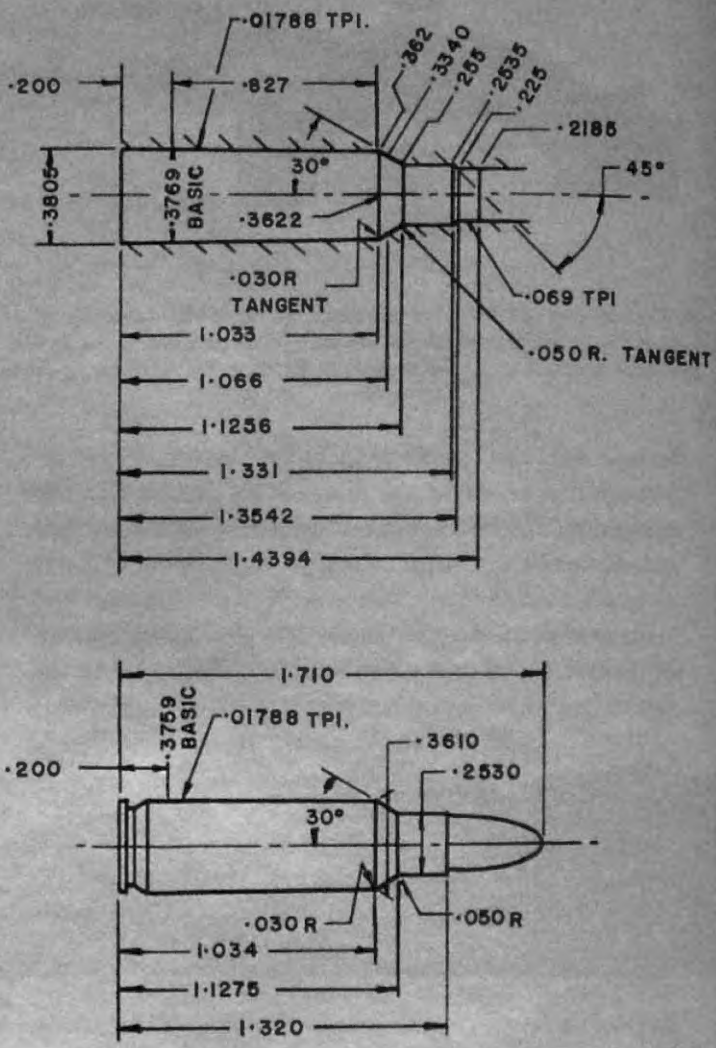
The mean radial dispersion of the caliber .22 ammunition was only 28% at 100 yards and 52% at 300 yards of that of the unselected lot of caliber .30 ammunition used in this test ..Dispersion characteristics of the caliber .22 weapon/ammunition combination were far superior to..the standard .30 Carbine up to 300 yards, thus the hit probability is increased..

The maximum ordinate of the caliber .22 cartridge, over a range of 300 yards, is 48% and 16% of the caliber .30 Carbine and caliber .45 cartridges, respectively. The flatness of trajectory of the caliber .22 cartridge increases hit probability on man-size targets under battlefield conditions, because it makes range estimation errors relatively unimportant and sight changing, within 300 yards, unnecessary. With standard Carbine sights set to make the bullet hit the point of aim at 250 yards, the highest the bullet would rise above the line of sight would be approximately five inches, and it would strike about seven inches low at 300 yards. With the standard caliber .30 Carbine, having the same sight setting, the bullet would rise approximately 12 inches above the line of sight and fall about 15 inches low at 300 yards.

Remaining energy of the caliber .22 Carbine is only 164 ft. lb. (59% of that of the caliber .30 Carbine) at 300 yards; a widely used criterion for fragment lethality is 40 ft. lb. Preliminary wound-ballistics studies indicate that small-caliber, high-velocity bullets may have better "killing power" than heavier, larger-caliber bullets of equivalent energy, perhaps because the energy is expended more rapidly when the [velocity] factor is relatively large and the [mass] is small. This phenomenon, and quantitative values regarding it, will be further explored at the Biophysics Laboratory at Army Chemical Center..

Penetration performance of the caliber .22 bullets, even with the soft-lead-nose commercial types necessarily employed in this test, was far superior to that of the caliber .30 Carbine bullets when fired against hard and soft metal plates. When fired against body armor and helmets, the performance of the two cartridges was approximately equal.

The higher scores of the caliber .22 Carbine, when fired in comparison with the MI rifle over the B course of fire, indicate that the test weapon/ammunition combination is capable of delivering effective fire up to 300 yards. The fact that the Carbine weighs about 60% as much as the MI rifle and that each round of ammunition weighs only 35% as much



18. A drawing of the minimum chamber and maximum cartridge for the .22 Gustafson Carbine. Development and Proof Services, Aberdeen Proving Ground, November 13, 1952. Redrawn by Thomas B. Dugelby

as the caliber .30 round, are very important when considering the number of rounds which can be carried by each rifleman, especially in rough terrain..

The low energy of free recoil of the caliber .22 Carbine, especially when fitted with a compensator, makes it much easier to control in burst fire than are either the caliber .30 Carbine or the caliber .45 submachine gun...Five-shot bursts [prone, with bipod] from the caliber .22 Carbine averaged 20 inches and 38 inches for 200 and 300 yards, respectively.. data show that these are excellent patterns when compared to those of a caliber .30 Carbine, fired under the same conditions, and previous tests of conventional weapons indicate that extremely large targets would be required at these ranges to contain 5-shot bursts. It is beyond the scope of this program to evaluate burst-fire effectiveness from the tactical standpoint, but it is demonstrated that the [.22 caliber] weapon/ammunition combination gives markedly better burst-fire dispersion patterns than any other foreign, standard or experimental shoulder-fired weapon tested at this station to date.

Good weapon functioning was obtained during the 1,900 rounds fired during this test. The 3 stoppages encountered in the caliber .22 Carbine were unquestionably caused by lead shavings from commercial-type bullets...Bullets with crimping cannelures were not available for this test, however, such a bullet should be designed..so that the cartridge case can be crimped into the cannelure to afford rigidity to the assembled cartridge. This..prevents accidental bullet separation in the weapon.

Four velocity uniformity series were fired from the .224 Carbine Mann Barrel. The results are as follows for 20 rounds per load:

Bullet Type	*Bullet Wt (grains)*	*Powder Type*	*Charge Wt (grains)*	*Mean Instrumental Velocity at 78' (fps)*
WRA Full Patch	*35*	*IMR 4227*	*15.8*	*3,019*
Sisk	*41*	*IMR 4198*	*17.5**	*2,717*
Sisk	*41*	*IMR 4227*	*14.3*	*2,700*
Sisk	*41*	*IMR 4198*	*16*	*2,866***
		and IMR 4227	*2*	

** Case capacity.*
*** Muzzle velocity = 3,022 fps. This is the charge used in other phases of the program. The "blend" charge was employed because no standard IMR powder had completely suitable burning characteristics for the new cartridge.*

Conclusions

It is concluded that:

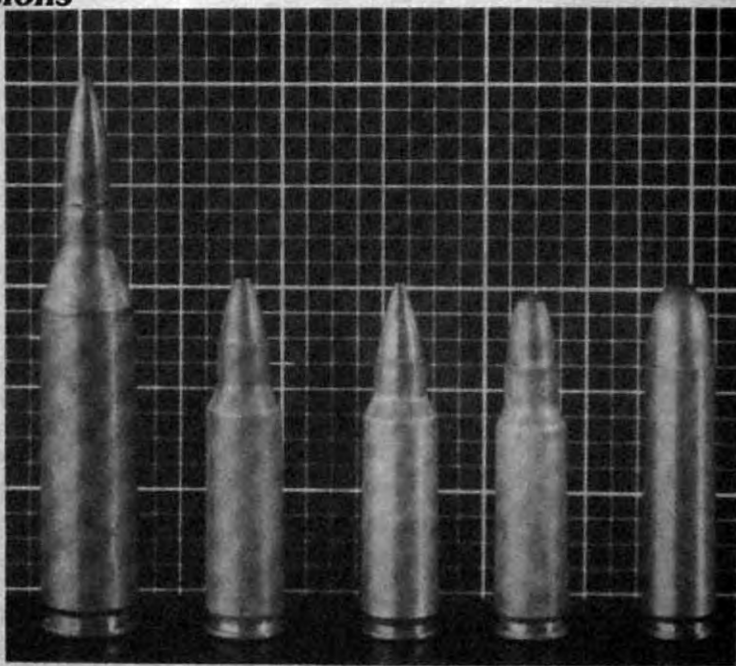
The M2 Carbine is capable of good performance when modified to fire caliber .22, 41 grain bullets to velocities in excess of 3,000 fps.

The caliber .22 Carbine performance, when compared with that of the caliber .30, M2 Carbine, was markedly superior with respect to velocity, trajectory, penetration, and accuracy in both semi- and full-automatic fire.

The caliber .22 bullets have less striking energy than the caliber .30 Carbine bullets at all ranges; however, the caliber .22 has more than enough energy to satisfy present criteria for lethality to ranges of at least 400 yards.

The extremely good burst-fire dispersion performance, the light weapon weight, and the high striking energy at close range, make the caliber .22 Carbine worthy of study as a replacement for the caliber .45 submachine gun.

The caliber .22 Carbine compares favorably with the M1 rifle in firing against regulation targets up to a range of 300 yards.



19. Further actual-size cartridge comparisons. From left: 1. Simplex (single-bullet) version of the .22/30 (5.56x51mm) Light Rifle experimental round known as the ".22 NATO", headstamped WCC 53. Compare with Duplex loading (fig. 68 no. 4); 2. hollowpointed .22 Gustafson S.C.H.V. round headstamped R - P ; 3. a full-patch .22 S.C.H.V. round headstamped WCC 54; 4. Mel Johnson's later ".22 Spitfire" (a necked-down .30 Carbine case) headstamped R - P 30 CARBINE; 5. a standard WWII-vintage .30 Carbine (7.62x33mm) ball M1, headstamped LC 4. Editor's collection

Recommendation

It is recommended that five caliber .22 Carbines and 20,000 rounds of ammunition be procured and tested at Aberdeen Proving Ground, in the presence of members from Army Field Forces, Board No. 3, to learn if ammunition of this type offers any military advantages over that now employed in Carbines, rifles or submachine guns.

Chapter Two

THE LIGHTWEIGHT ERA TRULY DAWNS

Homage to the *Kurz Patrone*

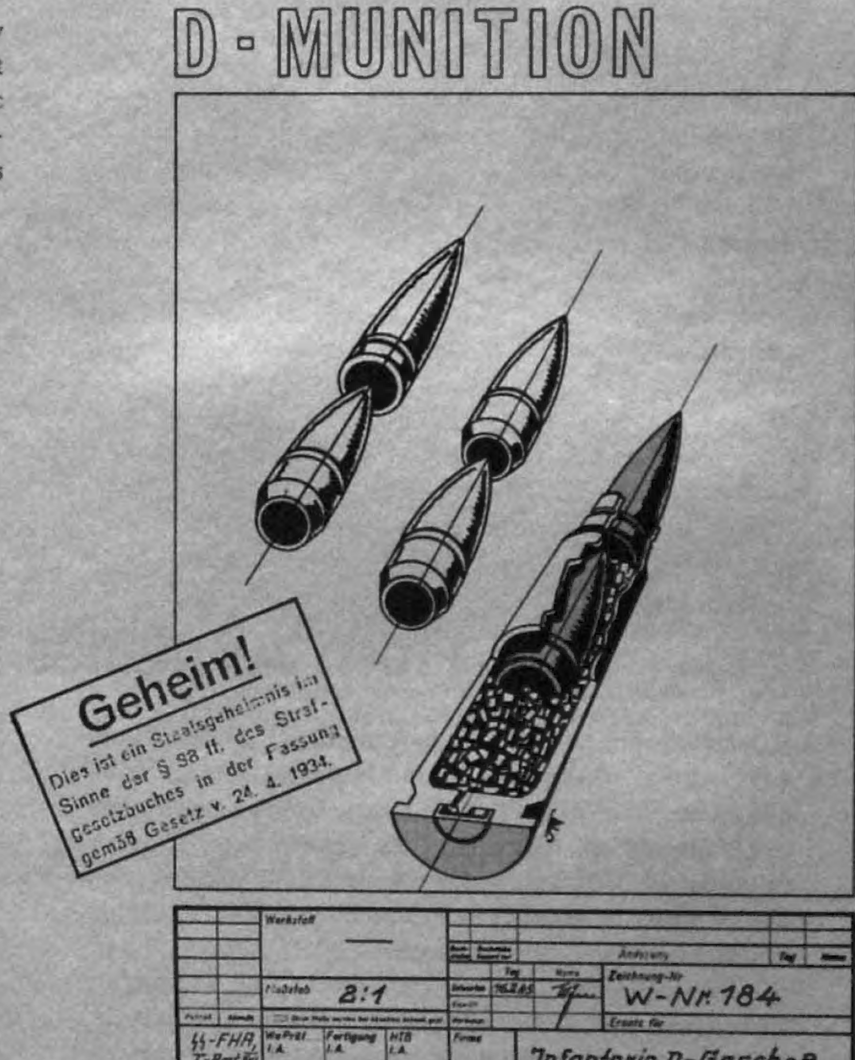
Following World War II the victorious Allies, particularly the Americans, purposefully laid the foundations for West Germany's military rearmament within the North Atlantic Treaty Organization (NATO). The following personal recollections of this period were later prepared by Monsieur Jacques Michault, a Brussels-based international arms broker:

In the early 1950s, Sidem International S.A., a corporation based in Belgium, was appointed by the US Army authorities in Germany to assist with the supply of infantry weapons for the newly-created German Border Police [Bundesgrenzschutz] which was to be the forerunner of the future West German Army. The founder and president of Sidem International, J. S. Michault moved his headquarters to Bonn, Germany, and became necessarily involved in the meetings between the US Army representatives and the German Ordnance officers responsible for the selection of infantry weapons. Jacques Michault asked his friend, Col. [Rene] Studler, to come to Germany to brief German officers on the merits of his [Studler's] own brainchild: the new caliber .30 short which was nothing more than the old US cartridge..cut down by 1/2"...The "new" .30 short was to become the NATO cartridge cal. 7.62.

The Germans were, of course, in favor of their own 7.92 Kurz Patrone, *developed during World War II for the* Sturmgewehr. *They were eventually obliged to opt for the US caliber .30-06 and later for the NATO cal. 7.62.*

In the course of these discussions, Col. Studler and Jacques Michault became interested in the German developments in the field of lighter and shorter infantry weapons manufactured and assembled from stamped metal parts and, possibly, alloys.

Further evidence of Col. Studler's interest in these German developments may be seen in *US Rifle M14*, wherein are discussed Cyril Moore's roller-locked T28; John Garand's final Armory project, the superlight bullpup T31; and the Clarke



20. Nothing New Under the Sun Department: In a desperate attempt to improve hit capability for the flagging Wehrmacht *in 1945, scientists at the Finower Industry ammunition works (headstamp code cg) revived an idea at least as old as the Civil War: multiple bullets. Forced to test their designs using mainly captured Italian gunpowder, the Finower Duplex-bullet trials were conducted with 7.92x57mm rifle cartridges loaded variously with two regular 7.92mm "S" bullets; one "S" bullet and one 7.92mm* Kurz Patrone *("K") bullet; and two "K" bullets in tandem. The last gave the best results. The original German report of February, 1945, translated into English as "German Duplex Bullet Experiments", lists the "D-Munition" (double ammunition) as effective from 100 to 300 meters, with a muzzle velocity of 536 meters/second (1,758 fps).*
Courtesy Daniel W. Kent

21. John Garand's misunderstood T31, two unfinished handbuilt prototypes of which constituted his final project for Springfield Armory. The magazine from the T31 was later chosen for the M14.
Springfield Armory photo dated April 6, 1949

Arms "clamshell" T33; all of which were built and tested under Ordnance Light Rifle contracts during the early fifties. [The story of the watershed modifications made to the FN FAL in support of its short-lived adoption as the NATO-caliber West German G1 rifle in 1958, is told in Collector Grade's *The Metric FAL*].

During a subsequent trip to California, Monsieur Michault became acquainted with George Sullivan, a self-styled "aeronautical engineer and patent attorney" who was working for Lockheed Aircraft Corp. Michault described what he had learned in Germany about lighter, cheaper infantry weapons. In turn Sullivan, a consummate salesman and "politician", acquainted Michault with the properties of some materials which were then being developed by the American aircraft industry; particularly stronger aluminum alloys, fiberglass and expandable plastics such as were used in the manufacture of helicopter rotor blades. M. Michault continues the tale:

Together, [Michault and Sullivan] conceived the idea of an aluminum rifle using a stock of fiberglass constructed like a helicopter rotor blade and with a straight in-line design which would require a higher sight. It was suggested that the sight could be used as a combination of carrying handle and scope mount. The idea of the AR-10 was born.

From Airplanes to ArmaLites

Yet another chance meeting took place in California during a 1953 aircraft conference, this time between George Sullivan and an executive of the Fairchild Engine & Airplane Corporation of Hagerstown, Maryland. Over lunch, Sullivan described the basic idea of the lightweight rifle with an in-line stock, and disclosed that he and Michault had already invested jointly in a machine shop in Hollywood.

As it happened, Fairchild's president, Richard S. Boutelle, was an avid hunter and "gun nut", and Fairchild was at that time looking for ways to diversify and expand its aircraft business. On October 1, 1954, discussions between Sullivan and Boutelle culminated in a mandate for Sullivan to continue his research as president of the newly formed, California-based ArmaLite Division of the parent east-coast aircraft company.

Sullivan and his brother-in-law, Charles Dorchester, had already been working on a bolt-action prototype of what they touted as a whole new range of fine, truly lightweight sporting rifles and shotguns. It was envisaged that both the anodized alloy parts and the foam-filled plastic furniture of such arms could moreover be offered in any color combination imaginable, combining with satin-finish or mirror-polished stainless steel to produce a rainbow of futuristic, superlight arms, all completely impervious to the elements. Under the 1954 arrangements, ArmaLite was to build and test the prototypes, which when perfected would be produced under license elsewhere, as Fairchild's board of directors resolutely opposed the capital outlay necessary to put ArmaLite into the business of actual volume production.

For the position of ArmaLite's plant manager, Sullivan naturally hired his brother-in-law and research assistant, Charles Dorchester. A former Marine and Army Ordnance technician named Eugene M. Stoner joined the firm as chief engineer.

22. Against a background of World-as-their-Oyster, ArmaLite president George Sullivan (left) and Charles Dorchester proudly display some early products. From left, Mr. Sullivan holds a proposed .22 caliber pistol version of the civilian AR-7, and a prototype AR-9 shotgun later marketed as the AR-17 (fig. 24). Mr. Dorchester holds two AR-5 .22 Hornet caliber survival rifles, one with a gold anodized finish and the other a 16"-barreled civilian model. In the foreground is one of the three-ever AR-16s, designed by Gene Stoner in caliber 7.62 NATO (figs. 156 and 157). *Photo courtesy Jean Huon*

The Earliest ArmaLites - the AR-1 and AR-3

ArmaLite prototype rifles were later given the prefix "AR-", along with a designating sequential number. The honor of beginning the series went to the lightweight bolt action rifle which Sullivan and Dorchester had been developing since pre-ArmaLite days. In its final form, the AR-1 was a bolt-action rifle chambered for the commercial version of the 7.62 NATO cartridge, the .308 Winchester. The AR-1 featured an aluminum Mauser-type receiver and an aluminum barrel fitted with a steel liner and barrel extension, into which the bolt lugs locked. This package was bedded in a foam-filled fiberglass stock, to give an overall weight with scope and sling of less than six pounds. In concept the AR-1 was described by ArmaLite as a "parasniper" rifle: a precision-made, lightweight weapon suitable for various military calibers, either as a top-grade sporting arm or for special sniper use. As recorded below, Springfield and Aberdeen later tested one of the very limited number of AR-1s that were ever made.

Gene Stoner had also brought along a commercial-type .308 caliber, rotary-bolt rifle design he had been working on. This became the AR-3, the first autoloading ArmaLite, with an aluminum receiver mounted in a "conventional" drop-heel fiberglass stock. A great deal was learned from tests of Stoner's model of the AR-3.

The ArmaLite AR-5 Survival Rifle

23. Left and right side views of the .22 Hornet caliber ArmaLite AR-5 survival rifle, called by the Air Force the MA-1. The tip of the stainless steel barrel liner is just visible at the muzzle of the aluminum barrel jacket. With the exception of the bright bolt handle and steel (M4) magazine, the metal parts on this particular AR-5 are red anodized aluminum.
Bob Miller collection, photo by Roy Arnold

ArmaLite's parent firm had a long history of working with the US Air Force. The personal friendship between Fairchild president Boutelle and General Curtis LeMay of the Strategic Air Command, both ardent gun fanciers, was well known. Indeed, the Fairchild C-82 and C-119 "flying boxcars" were the first aircraft designed expressly for airborne paratroop operations. It was therefore perhaps not surprising that the first new weapon actually brought to fruition within the ArmaLite group was designed by a former USAF survival expert and gunsmith named Robert Enewold, at the express invitation of General LeMay. This was the AR-5, a bolt-action, .22 Hornet caliber rifle whose basic design resembled the earlier stamped-and-welded, wire-stocked H&R M4 survival rifle, even to the point of using the exact same 4-shot clip.

The magazine was the only "regular" steel part in the AR-5, however. The receiver and barrel were aluminum alloy, the latter fitted with a stainless steel liner. The entire rifle, which weighed only 2 lb. 6 oz., was designed to be disassembled without tools and stowed in hollow compartments inside its own rather outsized fiberglass-and-foam-plastic stock, which also held some ammunition and a small basic survival kit comprising a compass, matches, needles, fish line and hooks. Snapping the butt cap back in place over the stowed parts turned the AR-5 into a compact package only 14" long, an easy fit in the standard Air Force bailout pack. The AR-5 would float in water, even when assembled. The Air Force purchased 12 AR-5s for evaluation at Stead Air Force Base in Nevada in the fall of 1955, and after some minor modifications, adopted it in 1956 as the rifle, survival, MA-1.

More on the ArmaLite Weapons Family

24. The ArmaLite AR-17 2-shot, 12-gauge shotgun. Known as the "golden gun", all visible metal parts except the triggerguard, bolt and steel barrel extension/liner are gold-anodized aluminum, with brown plastic furniture. Bob Miller Collection, photo by Roy Arnold

The prototype of a new 12-gauge automatic shotgun called the AR-9 was also unveiled in 1955, featuring a daringly light aluminum barrel and receiver and plastic furniture. In the AR-9 a rotating, front-locking, multi-lugged bolt locked into a slender, one-piece steel barrel extension and chamber sleeve, which was finely threaded into the aluminum barrel. The AR-9 was later produced in limited numbers as the two-shot AR-17.

A later military ArmaLite project, the "AR-13 Hypervelocity Aircraft Gun", apparently never made it off the drawing board.

ArmaLite's most successful commercial arm, the AR-7, had to wait until the company emerged from under Fairchild's wing in 1960. Popular with campers and other outdoorspeople, the handy .22LR semiauto blowback AR-7 was produced and marketed for years by ArmaLite and later the Charter Arms Corp. as the "Explorer", featuring an 8-shot clip and the same floating, hollow stock plastic idea as the AR-5.

Meanwhile, although the AR-5 had been officially adopted as the MA-1, the 12 test guns were, ironically, all the Air Force

25. Closeup of the receiver of the ArmaLite AR-17 "golden gun" showing the rotary lugs on the bolt, which lock into the steel extension/liner of the barrel. The AR-17 functions on the short-recoil principle.

ever purchased. General LeMay was unable to get any further funding requests approved, the reason being that there were already sufficient numbers of earlier M4 and M6 survival rifles in Air Force stores. However, much had been accomplished for such a short time, and the "success" of the AR-5 had put ArmaLite on the military map, so to speak.

This, combined with the "know-how" which had accrued from building and testing the earlier designs, prompted a decision to apply the full force of Gene Stoner's considerable talents to the original, as-yet unformulated idea for an in-line military rifle. As a measure of the importance accorded this move by everyone concerned, no less a personage than the recently retired Commanding General of the Continental Army Command (CONARC), Jacob L. Devers, joined the staff of Fairchild as Military Liason Officer.

As discussed below, the fourth-prototype version of Gene Stoner's AR-10 was the first to be made in any but one-off numbers. When it burst upon the scene in 1955, the experience of first viewing and handling the AR-10's grey alloy metalwork and foam-filled plastic furniture seemed so utterly without precedent that for many it simply suspended the critical faculties, leaving nowhere to begin any comparison with ordinary wood-and-steel rifles. The AR-10 came complete with a very interesting "family tree", however, and in order to do justice to this epochal weapon itself we must retrace some steps and pick up yet another thread of our story.

Flashback: The Great Johnson/Garand Controversy of 1940

Bitter controversy, denigrations and accusations; investigations and whiffs of scandal: all these and more have attended the manufacture and issuance of a number of US Army shoulder rifles since at least the first Allin conversion of the Springfield rifled musket in 1865. The whole process seemed about to begin again when the US adopted the world's first general-issue semi-automatic rifle, the .30-06 (7.62x63mm) M1 Garand: many minds, military and otherwise, were far from convinced that the Army had made the right move.

The M1 was adopted in January, 1936. The following month, the original toolroom model of a new .30-06 short-recoil rifle mechanism was test fired for the first time. It was the brainchild of Melvin M. Johnson, Jr., a young man described in a later ***American Rifleman*** article as "a well-heeled Boston lawyer whose passion was the design of advanced rifles and machine guns". Johnson, also an officer in the Marine Corps Reserve, pursued the refinement and contract manufacture of several prototypes of his rifle with all of the considerable private resources he could muster. Nor was he hesitant about calling for help from his fellow officers: in March of 1938 he was allowed to conduct a week-long field demonstration before the Infantry Board at Fort Benning, with his rifle "serial no. 1". For his pains he received the following reminder that the US already had a rifle:

> *..until the [Johnson] rifle can be subjected to intensive test firing, such as has been done with the US Rifle, M1, no sound conclusions can be made concerning the ability of the rifle or its parts to stand up.*

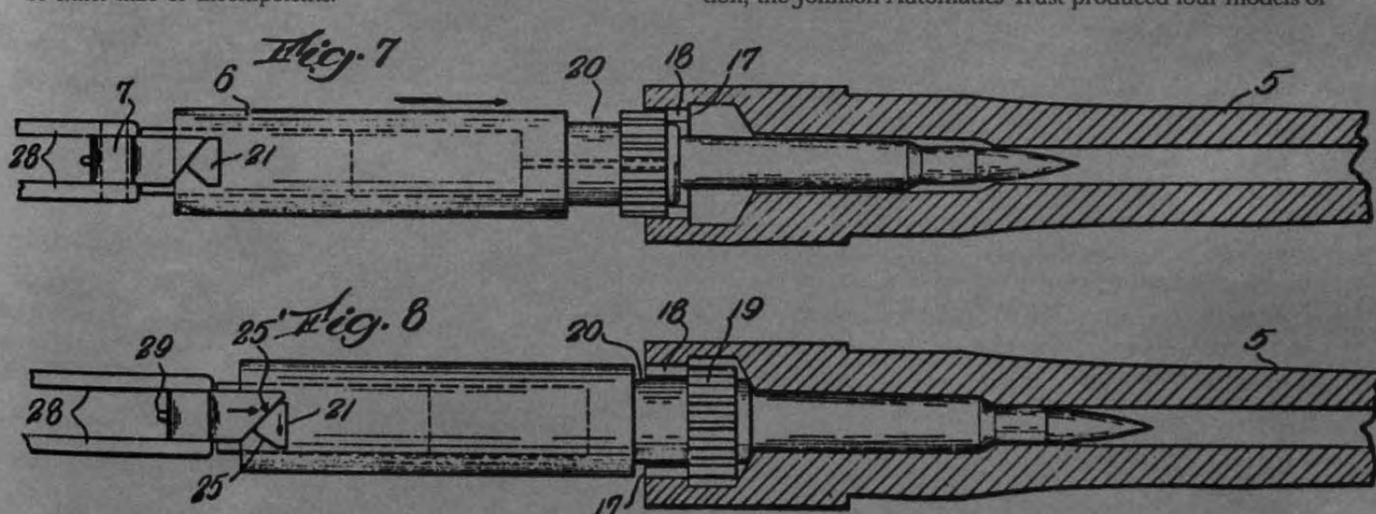
26. John Cantius Garand and the M1 rifle, in a National Rifle Association photo taken at Springfield Armory shorly before his death in 1974. The M1 was the world's first general-issue semi-automatic rifle, and many felt that it was an impossible design to mass-produce. Mr. Garand here holds "U.S. Semi-automatic Rifle Caliber .30 M1" serial no. 1, the first of more than six million which were eventually made.

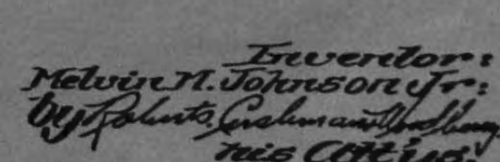
27. Melvin M. Johnson Jr.'s first working model of his short recoil action, hand-built in a shop in Boston in 1936. *Photo courtesy Bob Miller*

Meanwhile, predictably, Garand's newly adopted rifle was stumbling through some early "growing pains" and manufacturing hitches. The original gas cylinder, which took off the gas right in front of the muzzle, was found to be too easily fouled and in need of modification and retrofit. Professing himself "alarmed" by what he saw as weaknesses in the M1, Johnson presented improved versions of his own rifles later in 1938 and again in 1939, at Fort Benning. These weapons were politely tested and duly reported upon, but nobody expressed any desire to see them again. Convinced that the Garand was a flawed design, Johnson and his partner pulled some political strings and saw the matter read into the record of the Senate appropriations subcommittee. What had been essentially a non-issue escalated rapidly as the Johnson Automatics Trust submitted a 34-page document critical of Ordnance policies and the delays and costs of Garand production to the Chief of Ordnance, General Wesson. As the *Rifleman* noted, "[Johnson's] comments, fairly or unfairly, intentionally or unintentionally, made the Army Ordnance officers appear to be either liars or incompetents."

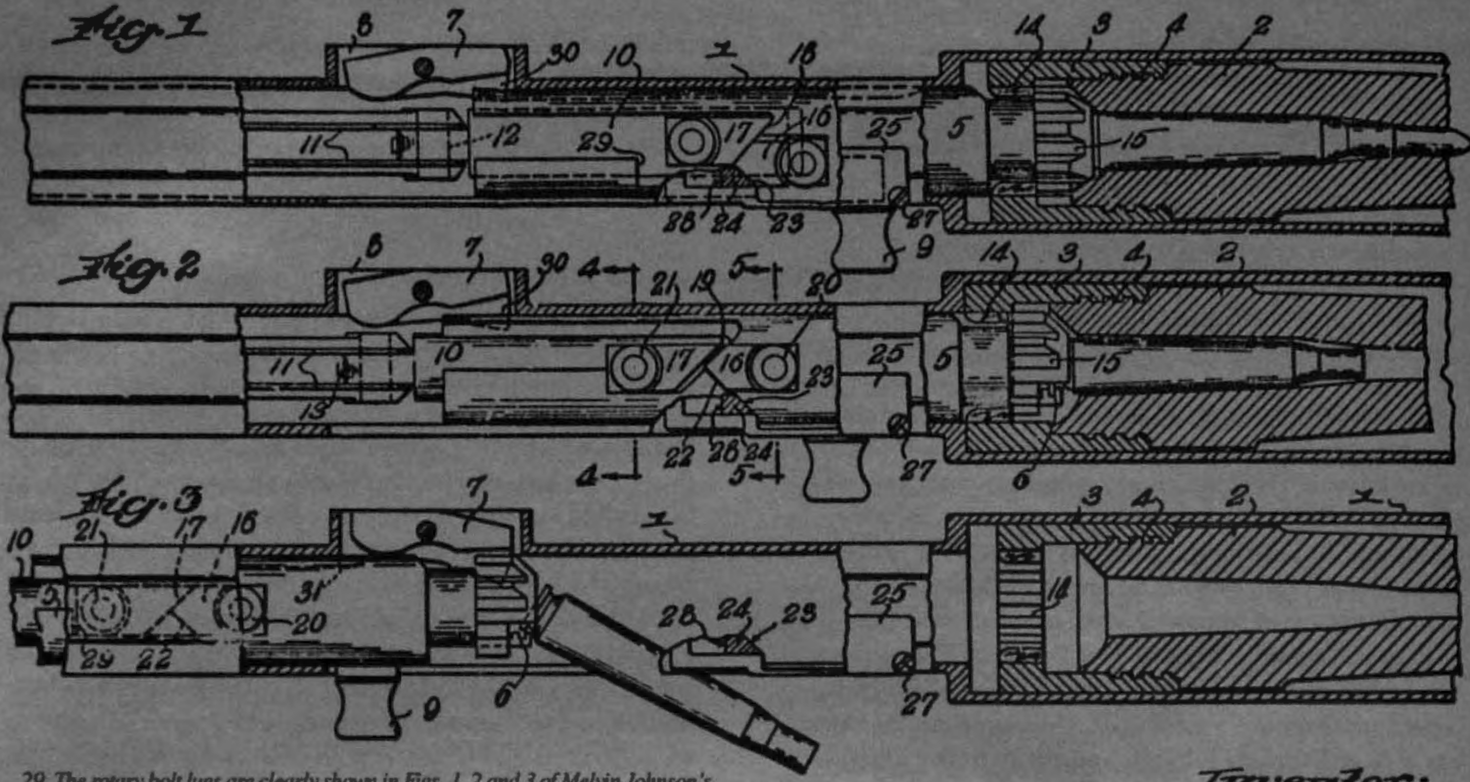
Unchastened, Johnson appeared again in 1940 before the Senate subcommittee, which heard him out before deciding that, with Garands already coming off the assembly line at Springfield Armory at the rate of 100 per day, their only practical course was to continue appropriations for the M1. In a final desperate move by the Johnson camp, the chairman of the full Committee on Military Affairs actually presented a Bill in the Senate to adopt the Johnson rifle as "United States semiautomatic rifle, M2, caliber .30". The Secretary for War himself had to recommend against such a move in order to finally put an end to the Johnson/Garand controversy.

Although never officially adopted, the story of the indefatigable Johnson and his rifle doesn't end there. Due to the exigencies of World War II, model 1941 Johnson rifles and light machine guns intended for Dutch East Indies forces saw action with US Marine Raider and Parachute battalions on Guadalcanal, and later in Europe with the Canadian-American First Special Service Force (later dubbed "The Devil's Brigade"). In addition, the Johnson Automatics Trust produced four models of





28. Figs. 7 and 8 from US Patent no. 2,094,156 entitled "Firearm", granted to Melvin M. Johnson Jr. on September 28, 1937. The action is described as follows: "When the bolt is in the locked position (fig..8) the locking lugs 19 are in front of the locking abutments 17..and the cam lug 21 is in the recess 23 in the side of the receiver groove...When the cartridge is fired the barrel and bolt recoil together and..the bolt is rotated to unlocked position by interengagement between the surfaces 24 and 25 of the receiver recess..and the cam lug 21 on the bolt. By this time the projectile has left the barrel and the breech pressure has dropped to a value which is little more than sufficient to retract the bolt to the rearward end of the receiver...As the bolt returns to its forward position it picks up a cartridge from the magazine..and when it reaches the forward position the pusher 7 cams the bolt into locking position.." *US Patent Office*

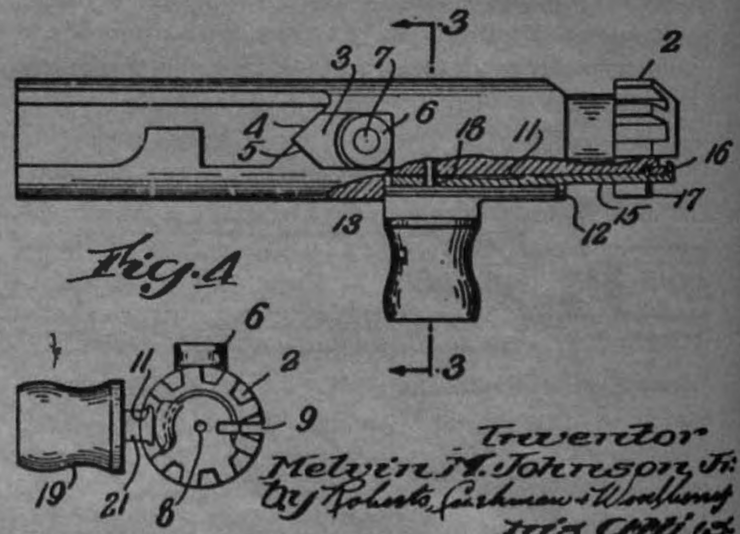


29. The rotary bolt lugs are clearly shown in Figs. 1, 2 and 3 of Melvin Johnson's second patent, no. 2,146,743, granted on February 14, 1939. Problems with friction and "initial extraction" necessitated the extractor "kicker" (part no. 10) and rollers on the bolt and carrier (nos. 20 and 21) to ride in the receiver recesses. Note the pivoted ejector (no. 7). US Patent Office

Inventor:
Melvin M. Johnson Jr.

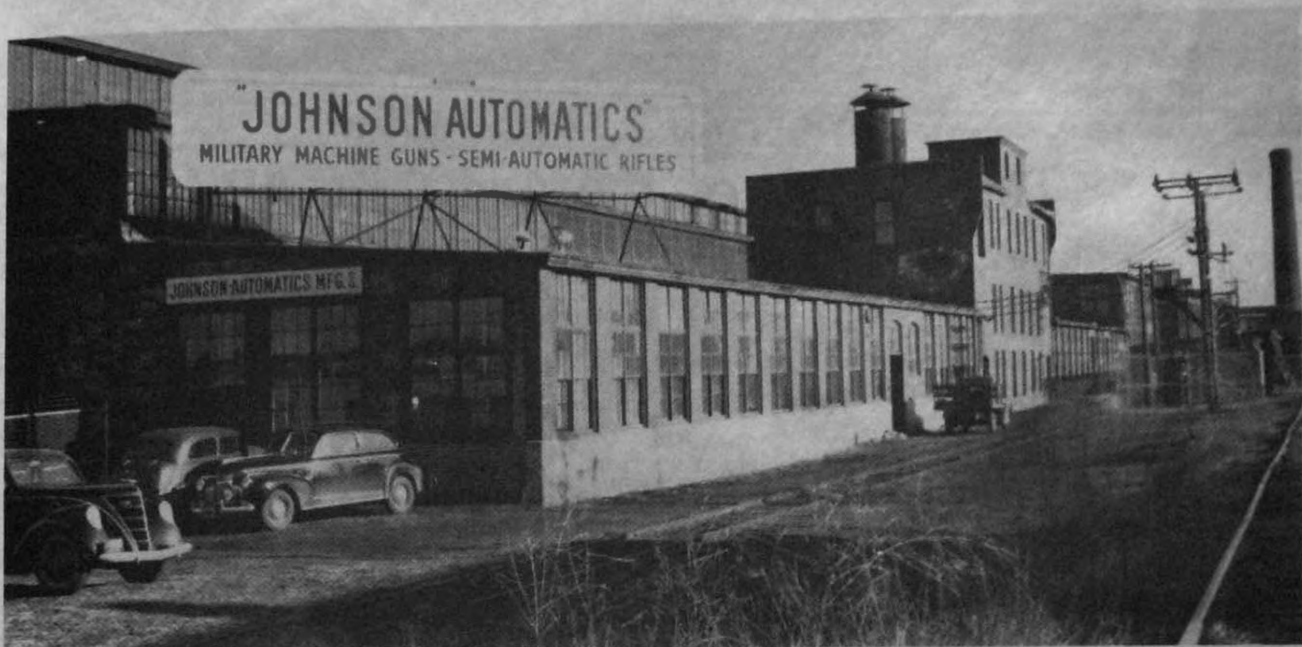
a 20mm automatic cannon known as the EX-2 for US Navy trials during the period 1942-1945. None went beyond the prototype stage, however, and the project was terminated at the end of the war.

After the war, Melvin M. Johnson Jr. continued his somewhat luckless involvement with military firearms by becoming a research consultant for the Operations Research Office (ORO). This led to the development of the Johnson "Spitfire", a sporting version of the Gustafson .22 caliber Carbine, but chambered for the necked-down .30 Carbine case (fig. 19 no. 4). By the middle fifties, Johnson was also acting as the east coast military rifle consultant and publicist for the parent company of a small California armaments division called ArmaLite.



30. A much more compact bolt-and-carrier were featured in Johnson's third patent, no. 2,181,131 of November 1939, entitled "Breech Mechanism". US Patent Office

31. The first prototype of the 14.5-lb. Johnson .30-06 Light Machine Gun, offered for military sale in 1938-39. Note the 20-round BAR magazine.



32. From the first edition of the Instruction Manual for the Johnson Light Machine Gun comes this picture of the Johnson Automatics Manufacturing Company plant in Cranston, Rhode Island, the "Home of Johnson Semi-Automatic Rifles and Machine Guns". Photo courtesy Bob Miller

33. Mel Johnson firing an early toolroom model of the "Light Machine Gun Type H", first produced by the newly renamed Johnson Automatics Incorporated in 1941 as the Johnson Machine Rifle Model of 1941. Caliber .30-06; weight 14.5 lbs; horizontal box magazine capacity 25 rounds.

"Tomorrow's Rifle Today" - The Genesis of the ArmaLite AR-10

Along with a diploma from the school of hard knocks, Mel Johnson brought ArmaLite another contribution of even greater value. The eight-lugged bolt of Stoner's AR-10, and its method of locking into the barrel extension, is a direct adaptation of the design used in Johnson's rifles since his earliest patent of 1937.

The outspoken Johnson was also a persuasive and prolific author, having written numerous articles and several critical, not to say audacious, histories of modern weaponry. In 1955 he wrote the article excerpted below in praise of the AR-10 for *Ordnance* magazine. (Rather ironically, the article did not appear until two years later in the May-June 1957 issue, coinciding almost to the day with the announcement of the adoption of the M14 rifle. The similarity of the situation to the beginning of Johnson's own uphill, ultimately fruitless struggle twenty years earlier against the M1 could hardly have escaped him).

Characteristically, Johnson's promotional article on the AR-10 began with a sharply critical overview of the recent politics of Ordnance procurement (the system which had rejected his own rifle), only then going on to make no secret of the origins of the AR-10's bolt design:

For over the past twenty years, with few exceptions, there has been little inventive activity in arms by American industry. Army Ordnance arsenals have had to carry the brunt of creation and conception. Industry has performed chiefly advanced engineering and production.

All US ground and aircraft caliber .30 and .50 machine guns stemmed from John Browning's original 1900 patents, the US M1911 pistol and M1918 auto-rifle from early Browning patents, the M1928 submachine gun from Thompson (Payne) patents, the M1 Carbine of 1941 from Ordnance development contracts with Winchester, the M1 rifle from 1927-1936 Ordnance development, the M3 submachine gun from Ordnance World War II origination. (The Johnson weapons were of 1936-1941 private design.)

About 1934 a special Senate committee investigated US munitions manufacturers who were charged with promoting war for profit. This committee was headed by Senator Gerald P. Nye and counsel for the committee was Alger Hiss. In my opinion, based on some study, this "munitions-monger" hue and cry had a major adverse influence upon American military arms development.

At the same time the Baker Board report on military aviation recommended full recourse to the American aircraft industry for competitive development, even stating that the Government should not build airplanes...

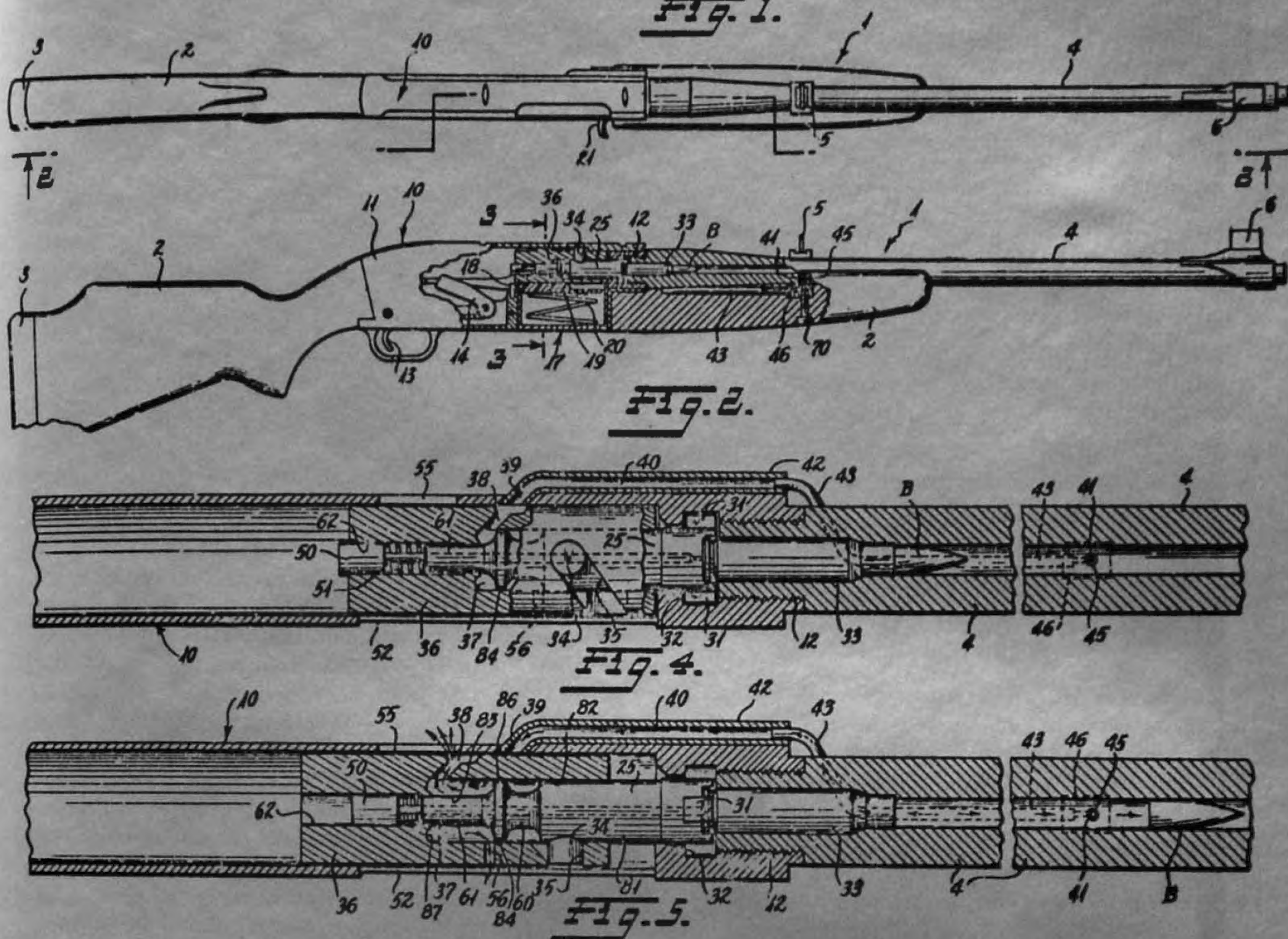
Among the half-dozen divisions of the Fairchild Engine and Airplane Corporation is ArmaLite of California... [which] has submitted a 7-lb light automatic 20-shot rifle, caliber 7.62mm..NATO.

The 40-inch Fairchild AR-10 rifle embodies a front-locked, 8-lug, 22.5-degree (Johnson type) turn bolt system, gas pipe actuated, which localizes maximum circumferential locking strength of bolt and barrel abutments within minimum space for minimum weight, especially as compared with the rear-locked T47, FN T48, and frame-locked M1-T20E2-T44.

Therefore, it is practicable in the Fairchild firearm to use an aluminum receiver-frame and housing, a principal weight-cutting design conception.

Johnson thus hailed the AR-10 as the first design ever to take full advantage of the bolt-to-barrel-extension lockup idea, wherein the forces of firing are largely confined *within* these locked-together parts. Capitalizing on this, Stoner had designed both the upper and lower receivers of the AR-10 to be fabricated from light aluminum alloy forgings.

In creating the AR-10, Stoner had married adaptations from several other arms to the modified Johnson bolt-and-carrier. As Johnson mentioned, Stoner's gas system utilized a simple open pipe, a concept first used in the Swedish Ljungman Gevar 42 and the later French 1944 and 1949 MAS semiautomatic rifles. In these relatively rudimentary applications, the gas piston and spring of a conventional gas-impingement system were replaced by the jet of hot gas itself, which travelled back through the hollow gas tube and impinged directly onto the face of the bolt carrier. The kernel of genius in Stoner's gas system was that the AR-10's gas tube, running along the left side of the barrel under the handguard, fed the gas through lined-up ports in the receiver and bolt carrier wall into a



34. Figs. 1 through 5 from Eugene M. Stoner's celebrated US Patent no. 2,951,424, entitled "Gas Operated Bolt and Carrier System". Gas, tapped at the gas port 41 travels through the "slideably engaged" gas tubes 43 and 42 (thus allowing for expansion as the barrel heated during firing), flows through the receiver port 39 and connecting port 38 in bolt carrier 36, and enters the "annular chamber" 37. The bolt carrier is thus pushed rearward, rotating and unlocking the bolt 25 by action of its projecting lug 34 in the bolt carrier's helical slot 35. *US Patent Office*

INVENTOR
Eugene M. Stoner

BY

ATTORNEY

chamber formed between the tail of the bolt and the surrounding bolt carrier. This forced the bolt carrier back. After about 1/8" of movement, the port in the carrier no longer lined up with the port in the receiver, and the further flow of gas was cut off. The momentum already imparted was sufficient to keep the bolt carrier moving, which unlocked the bolt by rotating it, due to a connecting cam pin, thus beginning the rearward cycle of operation. With the gas cylinder at maximum size and the bullet long since out of the muzzle, what little pressure remained was exhausted as a weak "puff" through slots in the right side of the bolt carrier. The AR-10, like the Johnson before it, made no provision for initial extraction, the bolt not moving back at all until the instant of complete unlocking.

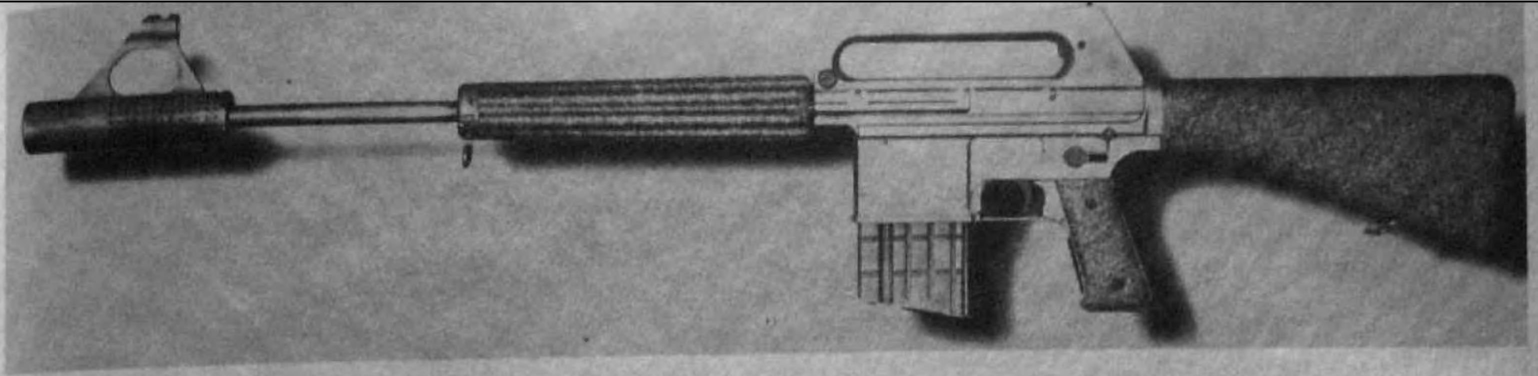
Stoner's original prototype of the AR-10 was chambered for the caliber .30M2 (7.62x63mm) cartridge, fed from a 20-round BAR magazine. It featured a straight, tubular stock and high sights, much like the 1941 and 1944 Johnson machine guns. After some study, improvements were decided upon which resulted in a second AR-10 prototype, completed late in 1955, in caliber 7.62mm/.308. The change in caliber meant a new magazine, which was also made of aluminum. Prototype no. 2 had no iron sights, being fitted over the receiver with brackets mounting a World War II German ZF-4 telescopic sight. Both these early one-off weapons used conventional steel barrels.

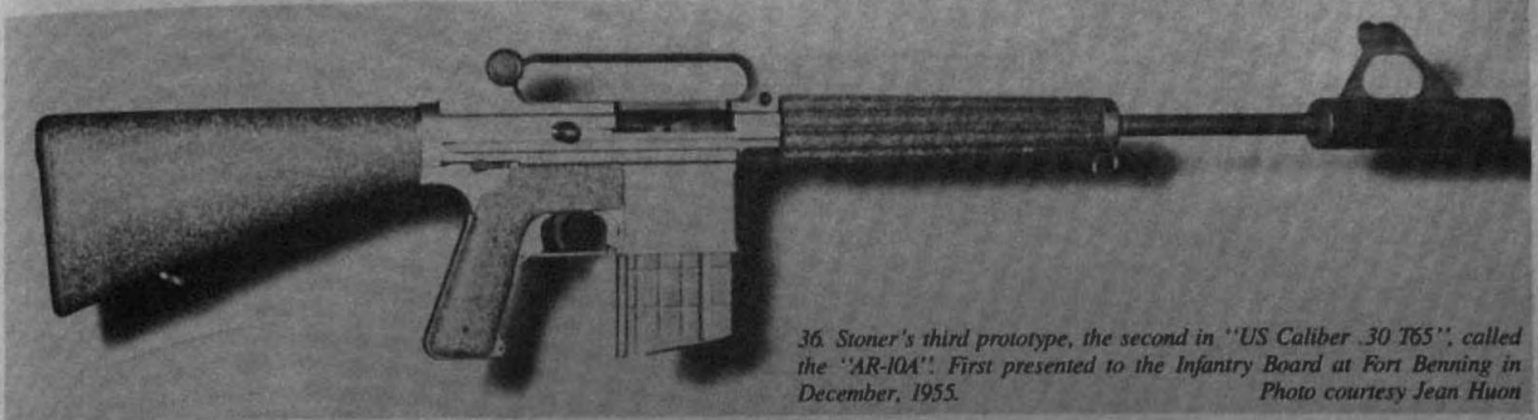
AR-10 prototype no. 3, dubbed the "AR-10A", featured a 4-oz. aluminum "waffle" magazine and a side-mounted

35. ArmaLite's chief small-arms engineer Gene Stoner stands proudly beside the four evolutionary prototype models of the AR-10. From top: no. 1, in caliber .30-06, with BAR magazine and Johnson rear sight; no. 2, in caliber 7.62/.308 with telescopic sight; no. 3, the "AR-10A" (fig. 36); and no. 4 the definitive American AR-10. *Photo credit:* Guns *Magazine, March 1957 issue*

cocking handle attached directly to the bolt carrier. Roughly the last six inches of the muzzle-end of the steel barrel were perforated and surrounded with a baffled and perforated duralumin cylinder which acted as a remarkably efficient flash and recoil reducer. The Sullivan/Michault "trademark" was continued in the stock, pistol grip and handguard, which were fiberglass-reinforced plastic shells filled with rigid plastic foam. The sole model of the AR-10A was first presented by Gene Stoner, George Sullivan and General Devers to the Infantry Board and School at Fort Benning in December, 1955. Throughout a busy schedule lasting well into the spring of 1956, the AR-10A performed well before a number of interested audiences, including CONARC HQ itself at Fort Monroe, Virginia.

For Fairchild, the relentless pace set for the development of the AR-10 was a calculated gamble with limited funds and an even more limited chance of success. Through the fault of no one, ArmaLite's entrance into the lightweight rifle race had been poorly timed, for even as CONARC expressed interest in the AR-10, the Ordnance Corps seemed on the verge of adopting one or the other of the T44 or the T48, both much more fully-developed weapons already in trials-quantity production in the US (discussed in ***US Rifle M14***). ArmaLite was thus doubly "under the gun", forced either to withdraw altogether or face a dubious future at best with a perfected AR-10.

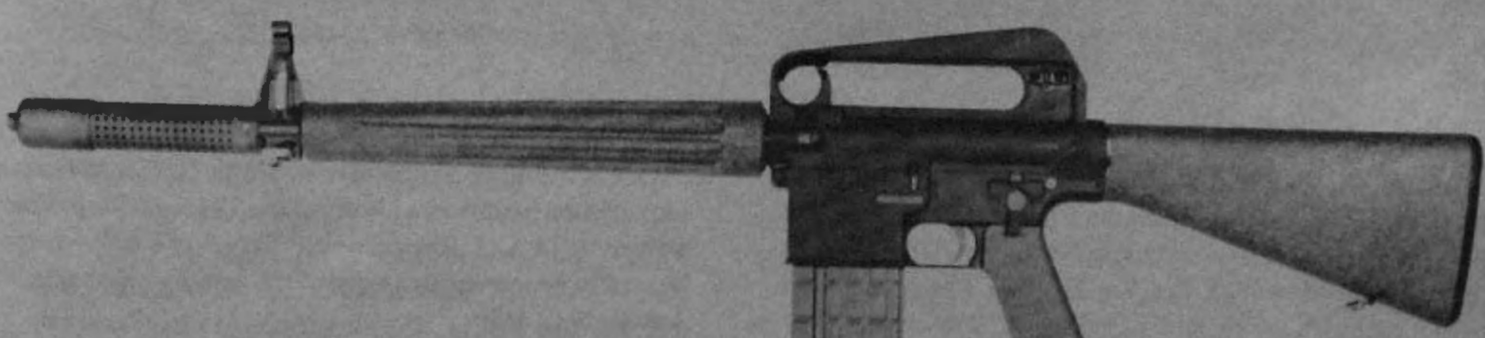


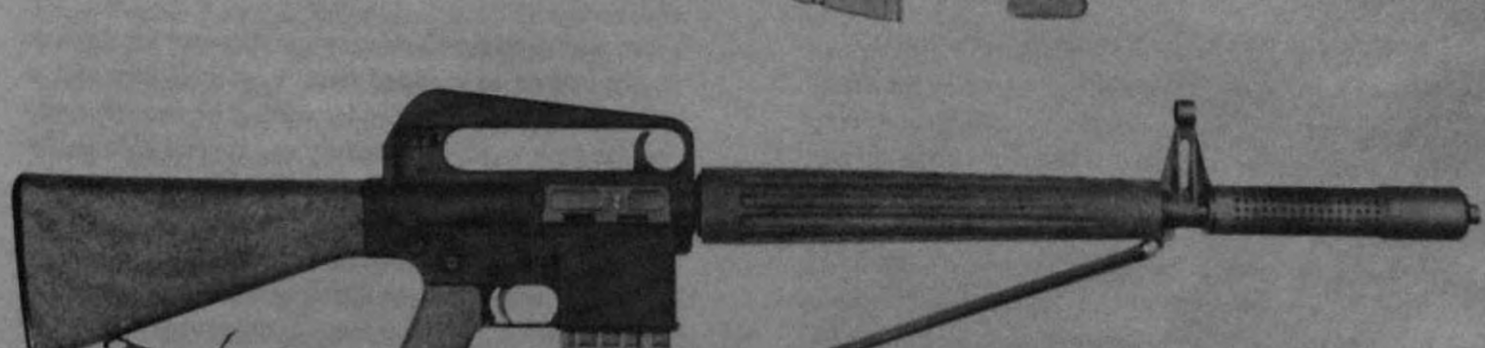


36. Stoner's third prototype, the second in "US Caliber .30 T65", called the "AR-10A". First presented to the Infantry Board at Fort Benning in December, 1955. Photo courtesy Jean Huon

Nevertheless, the demonstrations with the AR-10A were a threefold success. First, CONARC approved the Infantry Board's recommendation that immediate action be taken by Ordnance R&D to investigate the military potential of the AR-10. Of even greater importance, the decision was taken during the summer of 1956 to share the fruits of ongoing Project SALVO field trials with ArmaLite, so that they could begin to investigate the feasibility of a rugged, lightweight weapon *designed expressly for SCHV ammunition*. Finally, if proof was needed that the AR-10A had indeed created a sensation, the Ordnance Corps approached Fairchild with an offer of direct financial support for future ArmaLite developments, in exchange for ultimate proprietary rights to the final product. This offer was refused by the elated directors of the firm, who were quick to announce expansive plans of their own for the future of the AR-10.

In a desperate rush to keep up with Fairchild's enthusiastic press releases, ArmaLite was busy with a small-scale production run based on a fourth Stoner prototype. For maximum lightness, although apparently against Stoner's advice, the fourth prototype featured a composite barrel made of a steel barrel extension threaded to a rifled, high-tensile steel liner, the latter swaged inside an aluminum casing. This rifle was the forerunner of the definitive American-made AR-10, of which less than 50 were ever made.





37. Left and right side views of ArmaLite "AR-10B" serial no. 1004, one of two early prototypes featured in the Springfield Armory trial late in 1956. Springfield Armory photo, dated December 4, 1956

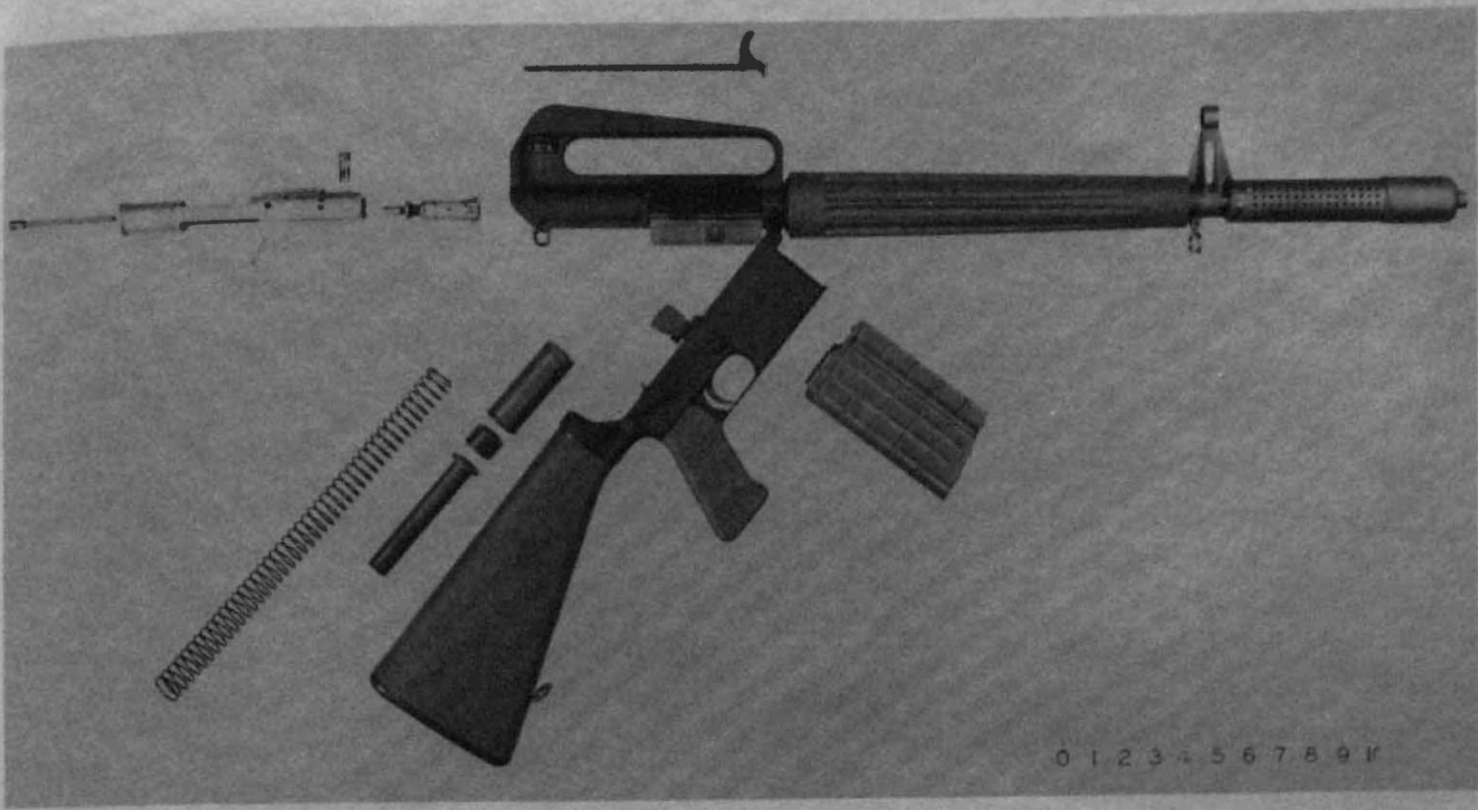
Springfield Tests the AR-10

38. AR-10 serial no. 1004 action closeup, right side view. Note the winter triggerguard and early spring-clip dust cover latch.

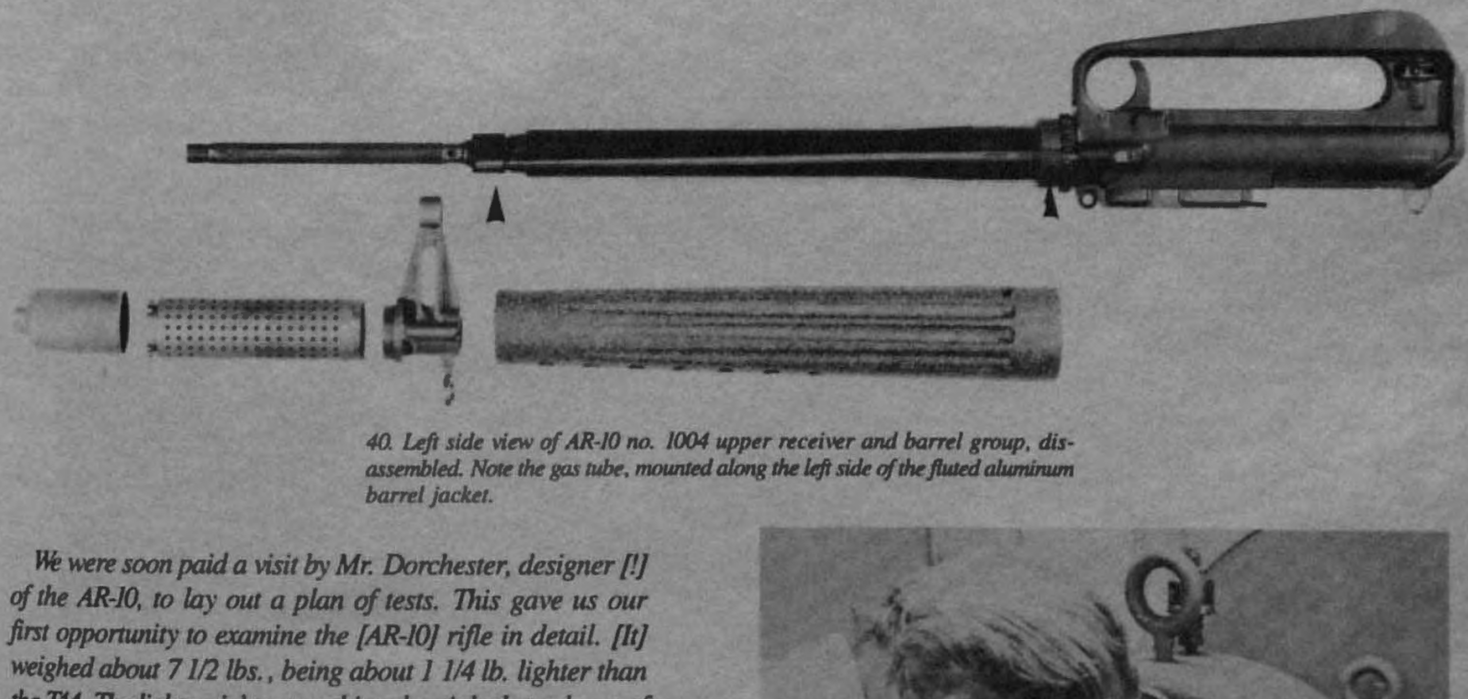
Meanwhile, CONARC's request for a military potential test of the AR-10 rifle had passed through channels to the Office Chief of Ordnance, and thence on to Springfield Armory, where it landed on the desk of Lt. Col. Roy E. Rayle, who commanded the Armory's Research and Development Division.

> *..In the fall of 1956 I received word that the Armory was to conduct a test of a new light rifle, designated the AR-10, which had been developed by..ArmaLite...We at the Armory had not seen this new rifle, but had heard of it being demonstrated at Fort Benning and Fort Monroe. The ArmaLite engineers had visited us some time earlier, but on other matters than the entry in the light rifle program. They had come to discuss new sporting rifle barrels they had been working on made wholly or partly of aluminum, both for advice and to see if we were interested in testing one such weapon. We felt that military rifles fired high energy loads at such rates that they would not hold up made of aluminum, even with the latest hard coatings. However we expressed more interest in a design involving a steel liner with an aluminum jacket. I had Dr. [Alexander] Hammer review this design for strength and accuracy on a theoretical basis, considering both heat and pressure. The design was somewhat similar to other composite designs we had considered. The design was found feasible, and could save perhaps half a pound in weight, but the barrel would be more expensive to make. We expressed interest to the extent of offering to test such a barrel in a commercial action under an arrangement where we would pay them $1.00 for the rifle, then in effect test it for them free of charge..*

One of the major sources of reference for *US Rifle M14* was an unpublished manuscript history of the T44 light rifle program written by Lt. Col. Rayle, entitled *Growth of a Rifle*, wherein he recalls the interesting period of the Armory's dealings with ArmaLite as follows:

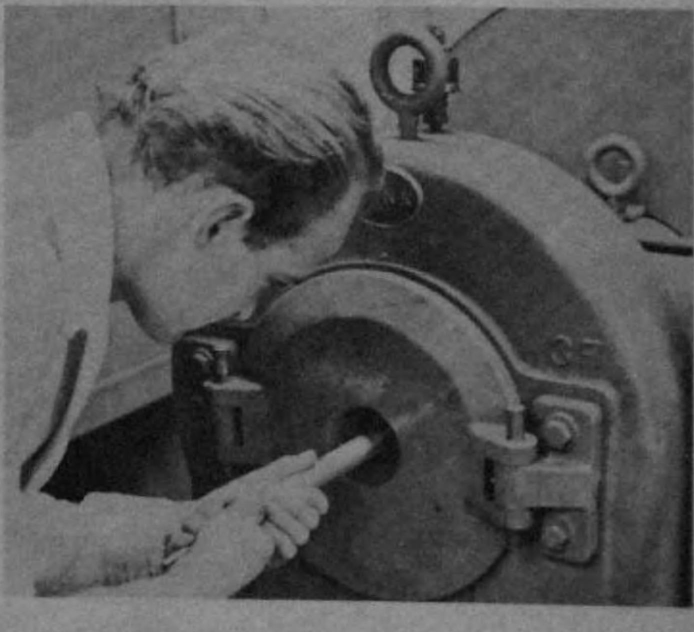


39. AR-10 serial no. 1004 right side view, stock and receiver group disassembled. Note the absence of the bolt carrier key: compare with fig. 53.



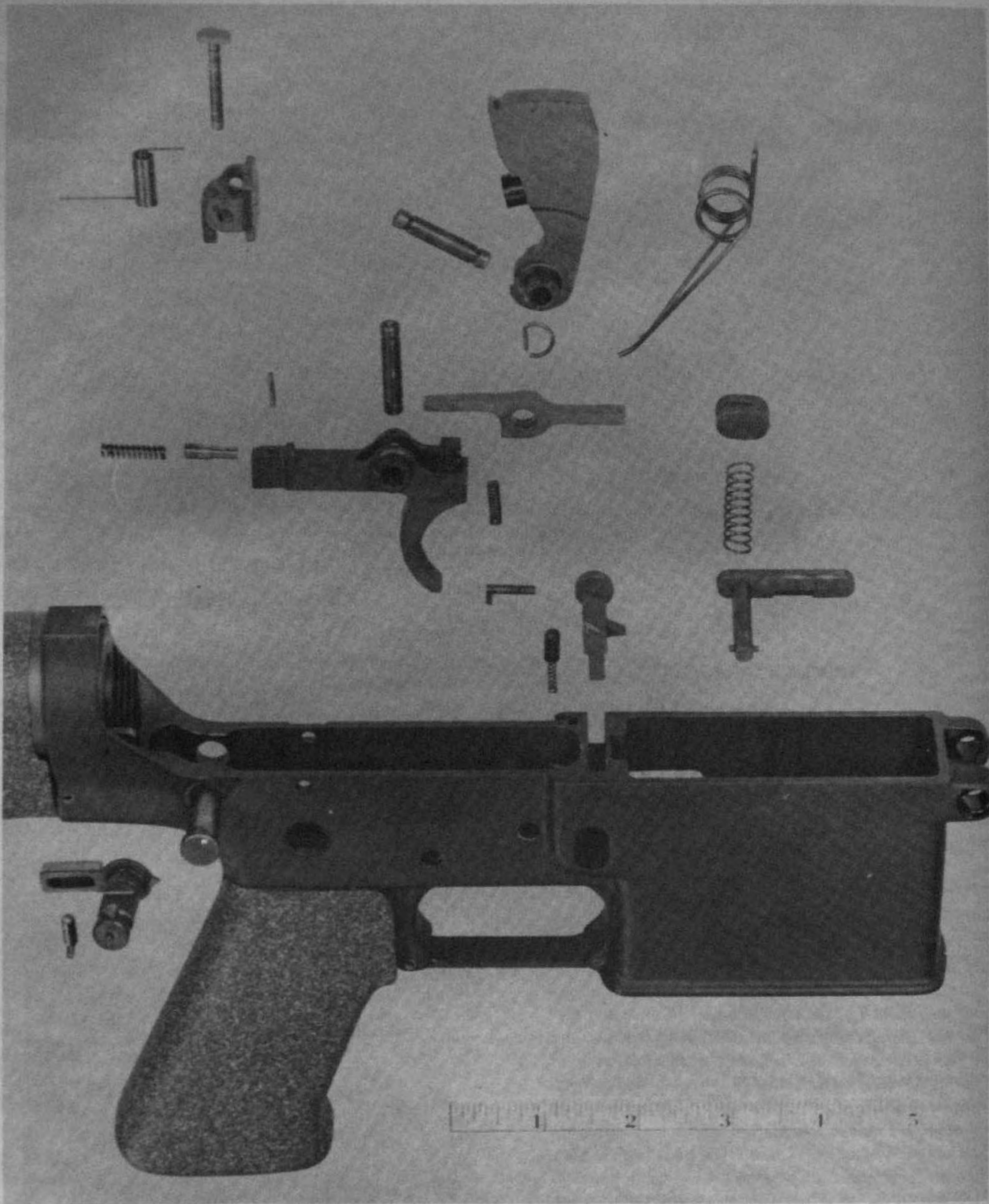
40. Left side view of AR-10 no. 1004 upper receiver and barrel group, disassembled. Note the gas tube, mounted along the left side of the fluted aluminum barrel jacket.

We were soon paid a visit by Mr. Dorchester, designer [!] of the AR-10, to lay out a plan of tests. This gave us our first opportunity to examine the [AR-10] rifle in detail. [It] weighed about 7 1/2 lbs., being about 1 1/4 lb. lighter than the T44. The light weight was achieved mainly through use of a foam-filled plastic stock and a composite steel and aluminum barrel. More weight was saved by eliminating bayonet and grenade launcher features. The weapon was gas operated, with the gas bled back through a tube and introduced to a space between the rear of the bolt and a bolt carrier, where gas pressure could supply energy to perform the functions of unlocking and reloading. The general idea of a gas system of this type was also incorporated in the T31 rifle, the last

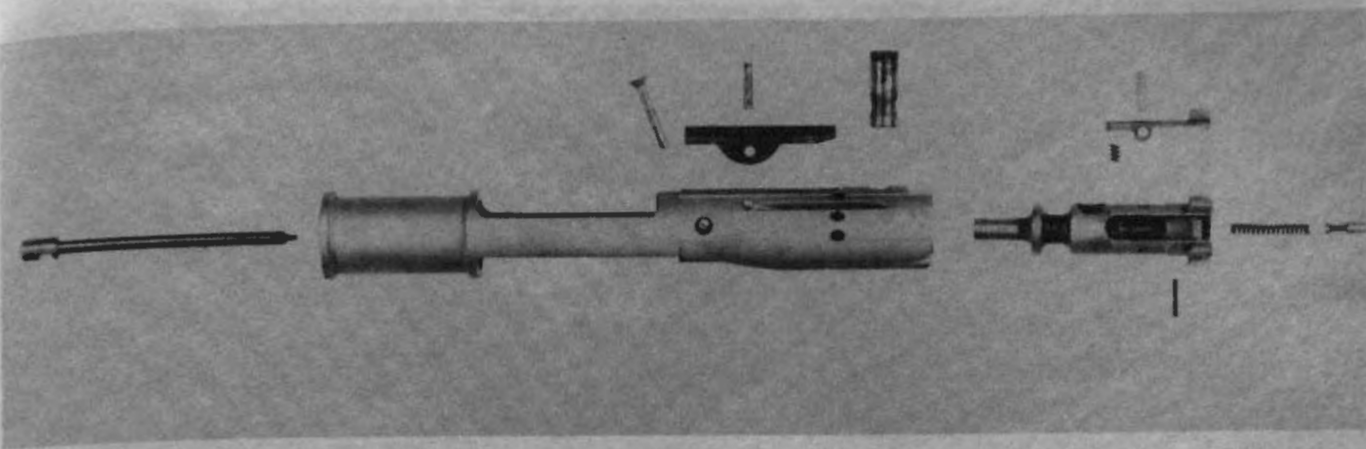


41. Swaging the extruded aluminum jacket onto the early AR-10's stainless steel barrel liner.

Photo credit: Guns Magazine, March, 1957



42. Exploded view of the trigger group from AR-10 no. 1004. Part of the documentation of Springfield's 1956-57 AR-10 trial.



43. Exploded view of the bolt group from AR-10 no. 1004.
Springfield Armory photo dated December 4, 1956

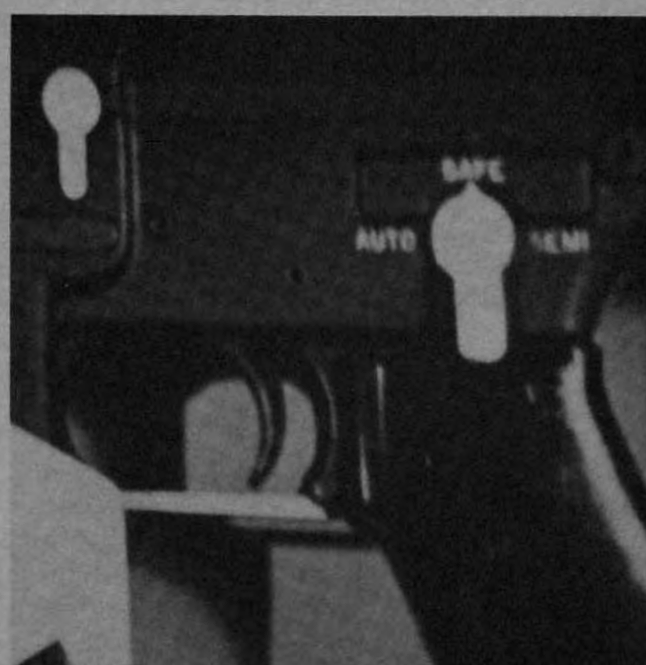
rifle John Garand worked on before he retired. In order to reduce the sharper recoil forces that would come from a lighter rifle firing the NATO cartridge a muzzle brake that looked something like a small can was used to trap emerging powder gases. A high front sight was used, and the rear sight was incorporated in a carrying handle. A 20-round box magazine was used, and in general, the rifle appeared to be designed to meet many of the objectives we were seeking in a new light rifle for the Army. A tentative test program was drawn up, based on the same type tests used with the T44 and T48 rifles. Mr. Dorchester requested one minor modification to the test and we agreed. Mr. Mel Johnson was retained by ArmaLite in the capacity of consultant to help insure the conduct of a fair, impartial test. Mel had severed his connections with Winchester, and was a free lance consultant at that time.

Testing of two rifles [serial nos. 1002 and 1004] began in mid December, but was soon stopped due to early failure of the combination muzzle brake/flash suppressor. Other problem areas included extractor breakage, sear failure, failure to feed, pierced primers, stubbed rounds, failure to eject, and warpage of the gas tube.

Early in January, 1957, the ArmaLite representatives returned with the modified prototype rifles, ready to resume tests. The muzzle brake was now made of titanium instead of duralumin, and the gas tube was made of 4130 alloy steel instead of stainless steel.

The first day or two we spent checking over the rifles again, weighing the weapons, having the ArmaLite representatives go over changes made, and finalizing the test program. We allocated one rifle [ser. 1002] to durability testing and the other [ser. 1004] to general performance testing.. [which] showed the gas tube warpage had been corrected. Recoil and muzzle blast were both under excellent control with the stronger, redesigned unit, although as testing proceeded, fouling began to occur and flash was no longer properly suppressed.

Tests under frost conditions and sub-zero temperatures revealed malfunctions which had not appeared in ambient testing. Also, we noticed that the rifles left overnight without complete cleaning had a tendency to freeze up from the effects of residue on sliding surfaces, and had to be jarred loose.

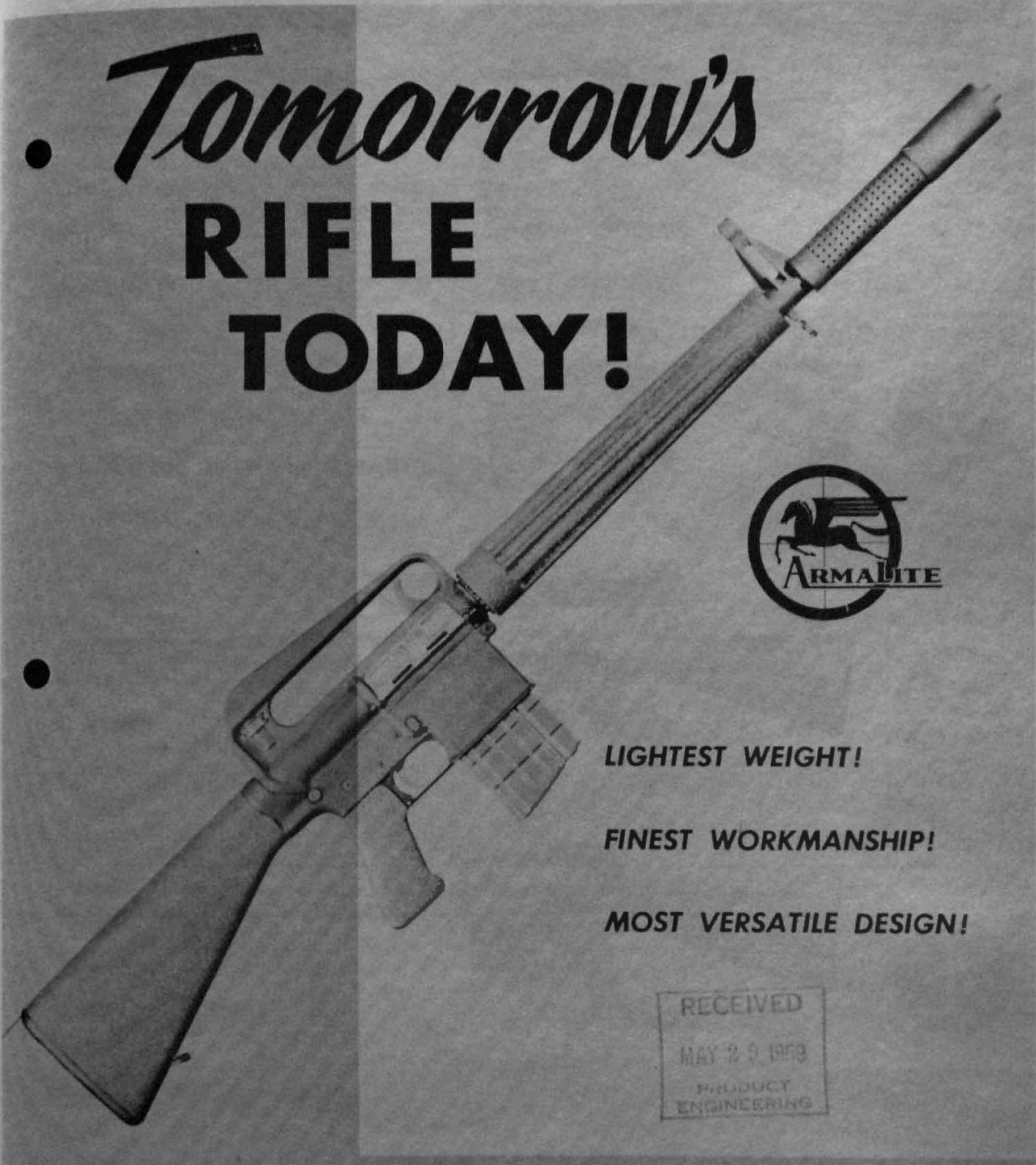


44. A still from an early Fairchild documentary promotional film about the AR-10. Note the selector lever position SAFE is straight up.

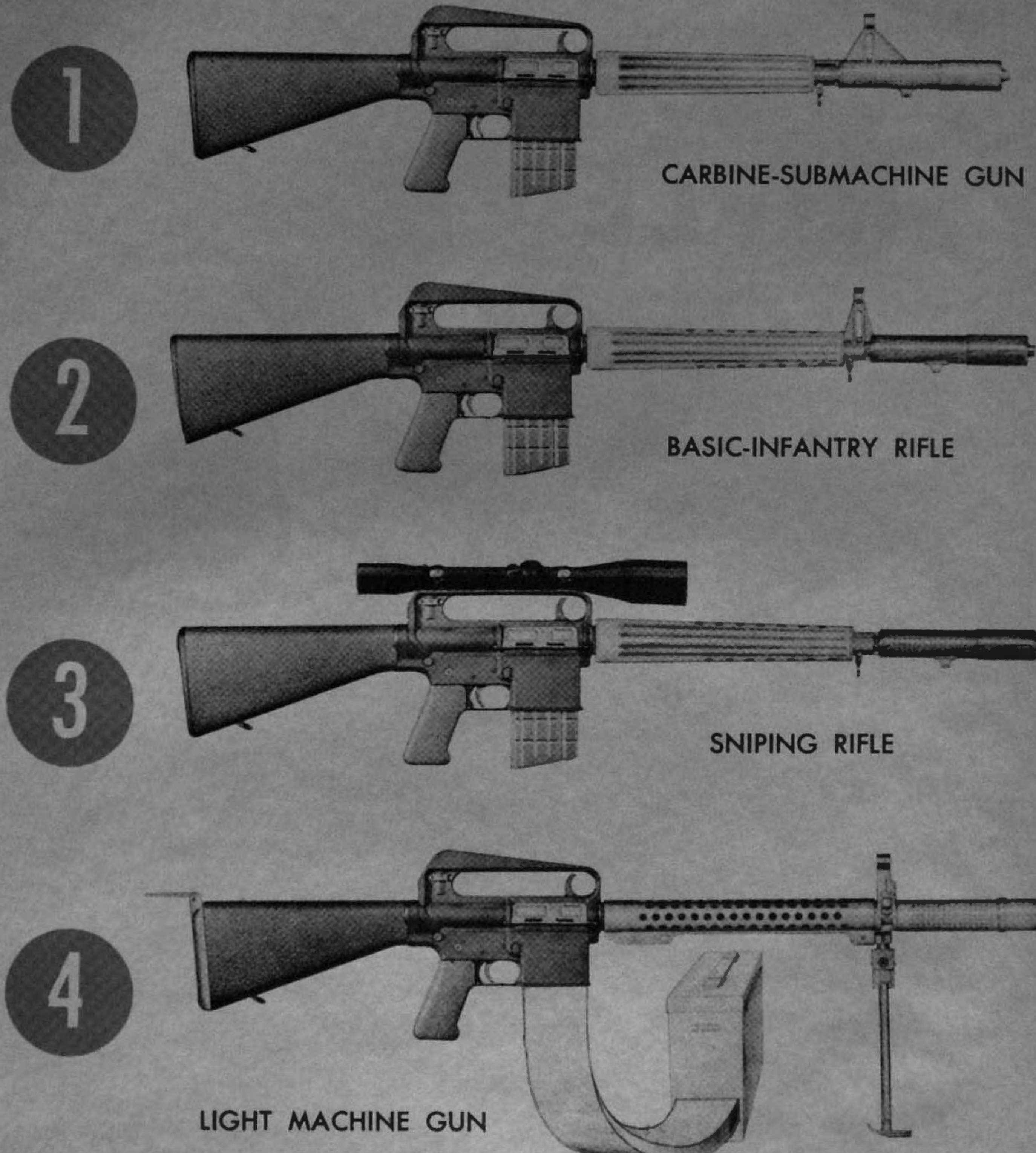
45. Pleased with their progress, Charles Dorchester and Gene Stoner examine AR-10 serial no. 1005 after a successful firing demonstration, while an unidentified admirer scrutinizes the bolt group.

After only a few days of testing we ran into a much more serious problem. We had not yet reached the most severe part of the test schedule, when a bullet came out the side of the barrel just ahead of the hand of the gunner holding the rifle. Naturally, this stopped the test. Our metallurgists were called in for investigation of the barrel material. It was learned that the steel liner, under the aluminum jacket, had been made of stainless steel, alloy type 416. Our experts advised that stainless steel of this type might possibly be satisfactory in a water cooled gun, but for an air cooled barrel operating over a wide temperature range, it would not have sufficient transverse strength properties. Furthermore, the high sulphur content, included to facilitate machining, caused sulphide stringers to occur where cracks could start and propagate. They also found that the barrel heat treatment used could have been improved for this particular application. We had developed through extensive research, a good military barrel steel of a chromium-molybdenum-vanadium alloy type, which withstood rather high barrel temperatures without rupturing. Stainless steel has very poor hot hardness properties compared to this alloy.

Mr. Dorchester learned of some of the excellent work Dave Mathewson in New Haven had done for us on the T44,



46. The cover of ArmaLite's original AR-10 brochure, listing Cooper-Macdonald, Inc. as sales representative. First received at Colt's Product Engineering Department on May 29, 1959. *Courtesy Bob Miller*

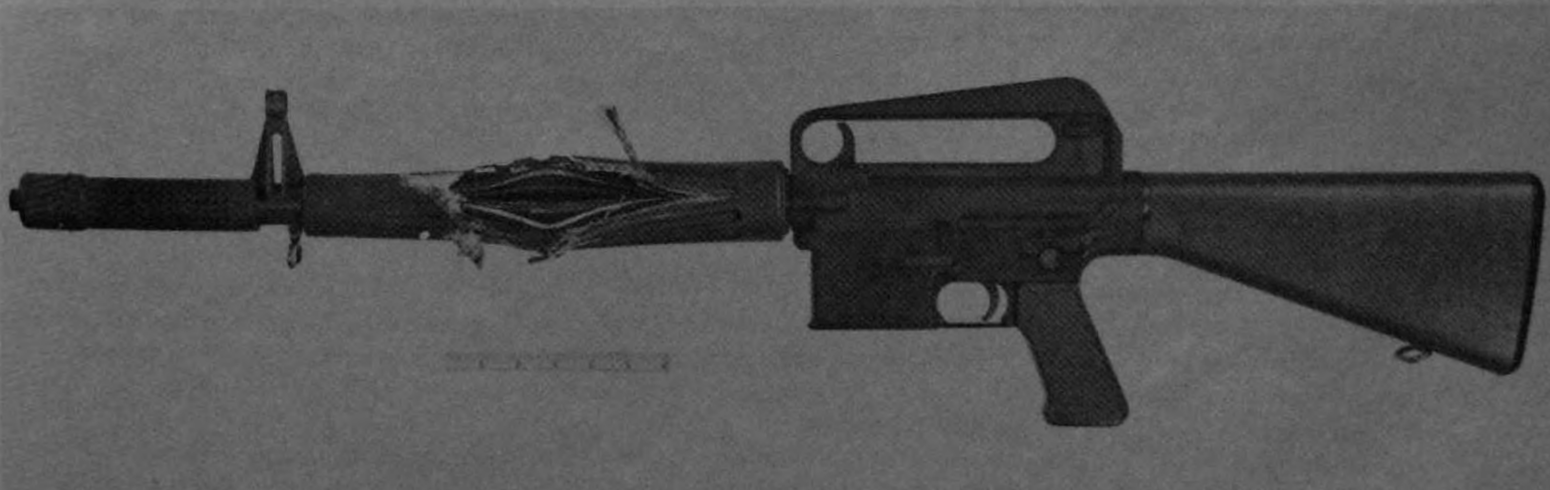


47. A page from the first ArmaLite AR-10 brochure illustrating ArmaLite's much-stressed concept of "Four Combat Functions in One Basic Weapon". One need look no further for the genesis of the multi-versioned Stoner 62/63 and Colt CAR-15 weapons systems (chapter 11). Compare with fig. 50.

so he approached Dave for assistance. Dave had some T44 barrel blanks on hand, and together [he and Stoner] worked up an all steel barrel design for the AR-10 as light as the original composite design by the technique of milling long slots or flutes in the barrel, in effect creating longitudinal stiffening ribs. By calling in some of his model makers to work overtime, Dave completed fabrication of the barrels over a weekend. Early the next week Mr. Dorchester was back at the Armory with the AR-10s now equippped with the new barrels and anxious to resume the tests. Before resuming tests we examined the design in detail, and checked it out theoretically for strength. Our calculations indicated the

	M-1	T-44	T-48 F.N.	AR-10
WEIGHT OF RIFLE	9.56	8.45	9.47	6.85
WEIGHT OF MAGAZINE	—	.53	.57	.25
LENGTH OVERALL	43.06	44.25	44.63	41.25
OPERATING ROD	YES	YES	YES	NO
TYPE OF FIRE	SEMI AUTO	SEMI AUTO & AUTO	SEMI AUTO & AUTO	SEMI AUTO & AUTO
CORROSION RESISTANT METALS	NO	NO	NO	YES
STOCK MATERIAL	WOOD	WOOD	WOOD	PLASTIC
CARRYING HANDLE	NO	NO	YES	YES
QUICK BARREL CHANGE (ON LMG)	NO	NO	NO	YES
WINTER TRIGGER	NO	NO	YES	YES
BARREL RADIATOR	NO	NO	NO	YES
DUST COVER	NO	NO	NO	YES
EFFECTIVE MUZZLE BRAKE	NO	NO	NO	YES
FRONT LOCKING BOLT	YES	YES	NO	YES

48. The gospel according to ArmaLite: how the AR-10 "stacked up" against its contemporaries.



49. While AR-10 no. 1004 was having its pictures taken, no. 1002 was undergoing "durability" testing. This Springfield photo shows the disastrous barrel failure suffered by AR-10 no. 1002 during the trial. The long splits in both the steel barrel and its aluminum jacket are clearly visible. Note the second type (titanium) muzzle brake, as noted in Lt. Col. Rayle's report.

design was safe to fire, and the testing was resumed. This time the testing was completed without further serious incidents, but a number of malfunctions were recorded. We were being urged by the Pentagon to complete our report and send it in, so by the end of February [1957] the report was finished. The ArmaLite engineers freely expressed their feeling that they had been rushed into this test prior to a chance to really work out many of the bugs in the rifle. Apparently Fairchild could see the Army was on the verge of selecting a new rifle and felt they should immediately submit the [AR-10] for Army tests. The report could do little more than record the various troubles we had experienced, and indicate that in its present form the rifle was not satisfactory as a military service rifle.

The AR-10's Short, Heady Life in the Fast Lane

Re-Enter the Dutch

Mention was made earlier of Johnson model 1941 rifles intended for the Dutch: a Netherlands purchasing commission had been stranded in America by the German invasion of the low countries in 1940, and had entered into a contract with the Johnson Automatics Trust to purchase 14,000 of what became the model 1941 semi-automatic rifle, and 500 light machine guns, for the defense of the Netherlands East Indies against the Japanese. Some initial deliveries were made, but Pearl Harbor changed all that: war was declared, and the US government temporarily froze all armament exports. By the time these restrictions were eased, the Rising Sun flew over all of Java and Sumatra, and there were no free Dutch East Indies forces left to ship to. More Johnson rifles and machine guns had meanwhile been produced and were awaiting shipment. These weapons, and all future Johnson production on the Dutch contract, were quickly diverted to the Marines.

To Fairchild, the US adoption of the M14 rifle in 1957 was more than a grave disappointment. Caught up in the heady aftermath of the successful Infantry Board trials, the parent firm had invested much more heavily than initially intended in the crash development of the AR-10. Coincidentally, it happened that negotiations had begun in 1956 between Fairchild and the Fokker aircraft group of Holland, regarding license to produce a Dutch-designed plane in the US. Fairchild president Boutelle learned that, although the Dutch Army had been testing the FAL and other weapons since 1954, no decision had as yet been made regarding a new Dutch service rifle. The ArmaLite AR-10 was soon introduced into the discussion, with the upshot being that in 1957 the long-established Dutch arsenal Artillerie-Inrichtingen of Zaandam, near Amsterdam, acquired the worldwide manufacturing rights to the AR-10 rifle. However, the viability of this program hinged very largely on certain "assurances" that the Dutch military would adopt the ArmaLite design. As Sidem's Jacques Michault, by this time back in Europe, recalls:

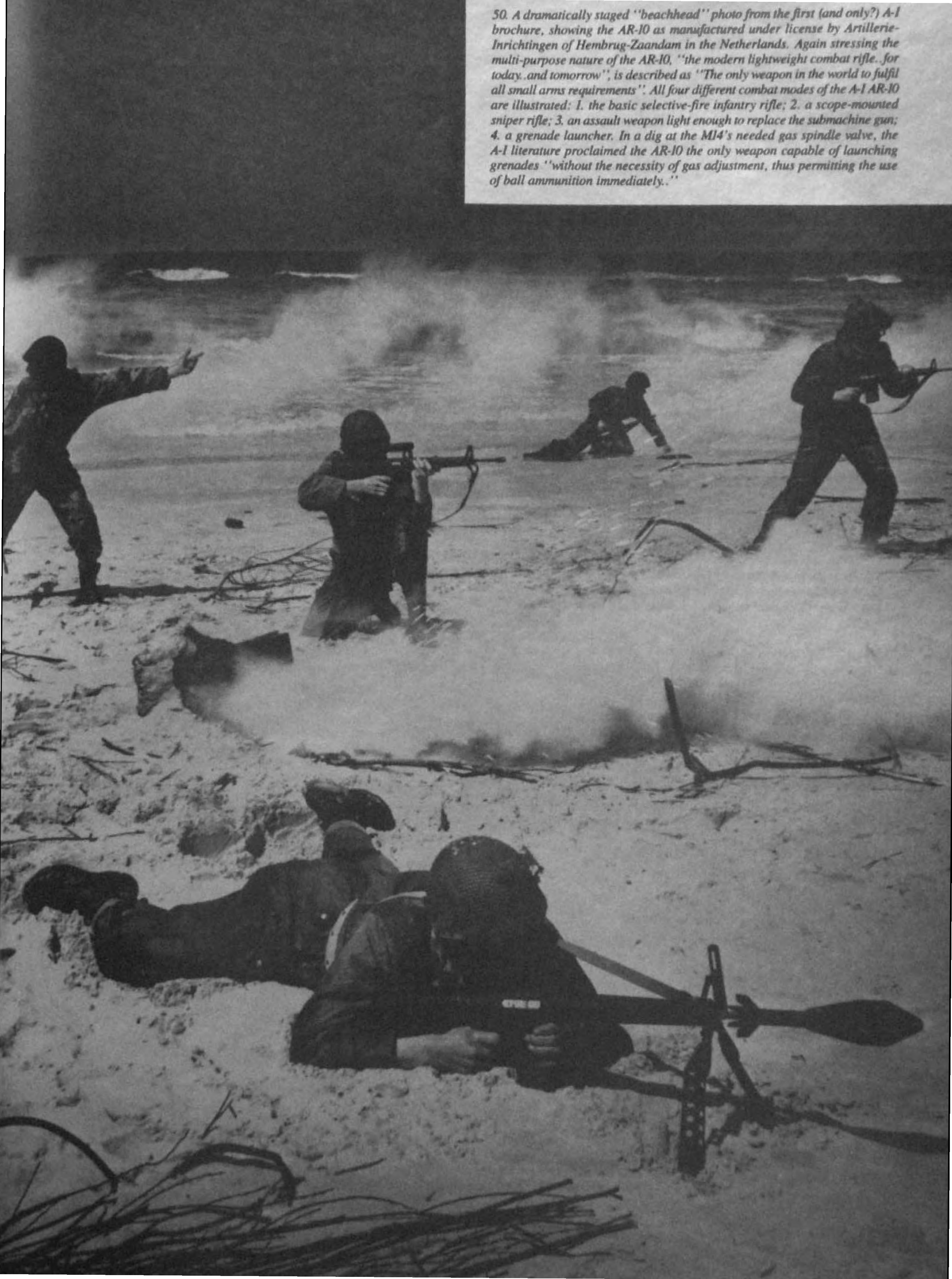
..While most of the European countries had already built prototypes of their [7.62mm NATO rifle] designs, Holland had not and Hans Jungeling, director of the Dutch arsenal ..negotiated a licensing agreement with Fairchild for production of AR-10 rifles in Holland. This was a breakthrough for the ArmaLite rifle because Jungeling was convinced that the Dutch Army would adopt the AR-10 made in their country..

Artillerie-Inrichtingen invested two and a half million dollars in the production line for the AR-10 rifle. The installation boasted the first vertical cold forging machine developed in Austria for the production of rifle barrels..

Gearing up for Production - the Gas System Goes on Top

As a result of the barrel failure during the Springfield trial, ArmaLite had abandoned all further experiments with "composite" military rifle barrels, and the "final, improved" fourth prototype version of the US-made AR-10 now featured a conventional steel barrel, fluted under the handguard for maximum strength and lightness. By this time, a newly-hired ArmaLite engineer by the name of L. James Sullivan had completed a final set of toleranced AR-10 production drawings. In the interests of economical manufacture, Sullivan (no relation to ArmaLite founder George Sullivan) had redesigned the original Stoner gas system, relocating the gas tube from the side to its now-familiar position on top of the barrel. A new part, the bolt carrier key, was designed to mate with it.

At Artillerie-Inrichtingen, converting the inch-dimensioned American drawings to the metric system proved more difficult than expected, requiring several trips to Holland on the part of the ArmaLite engineers. In addition, the Dutch Army had



50. A dramatically staged "beachhead" photo from the first (and only?) A-I brochure, showing the AR-10 as manufactured under license by Artillerie-Inrichtingen of Hembrug-Zaandam in the Netherlands. Again stressing the multi-purpose nature of the AR-10, "the modern lightweight combat rifle..for today..and tomorrow", is described as "The only weapon in the world to fulfil all small arms requirements". All four different combat modes of the A-I AR-10 are illustrated: 1. the basic selective-fire infantry rifle; 2. a scope-mounted sniper rifle; 3. an assault weapon light enough to replace the submachine gun; 4. a grenade launcher. In a dig at the M14's needed gas spindle valve, the A-I literature proclaimed the AR-10 the only weapon capable of launching grenades "without the necessity of gas adjustment, thus permitting the use of ball ammunition immediately.."

stipulated that their new rifle should be capable of launching rifle grenades, which required a diameter of 22mm on the muzzle end of the barrel. Thus came the demise of the "tin can" muzzle brake and flash hider, hitherto part and parcel of the AR-10's ability to deliver controllable automatic fire from a truly lightweight NATO-caliber rifle.

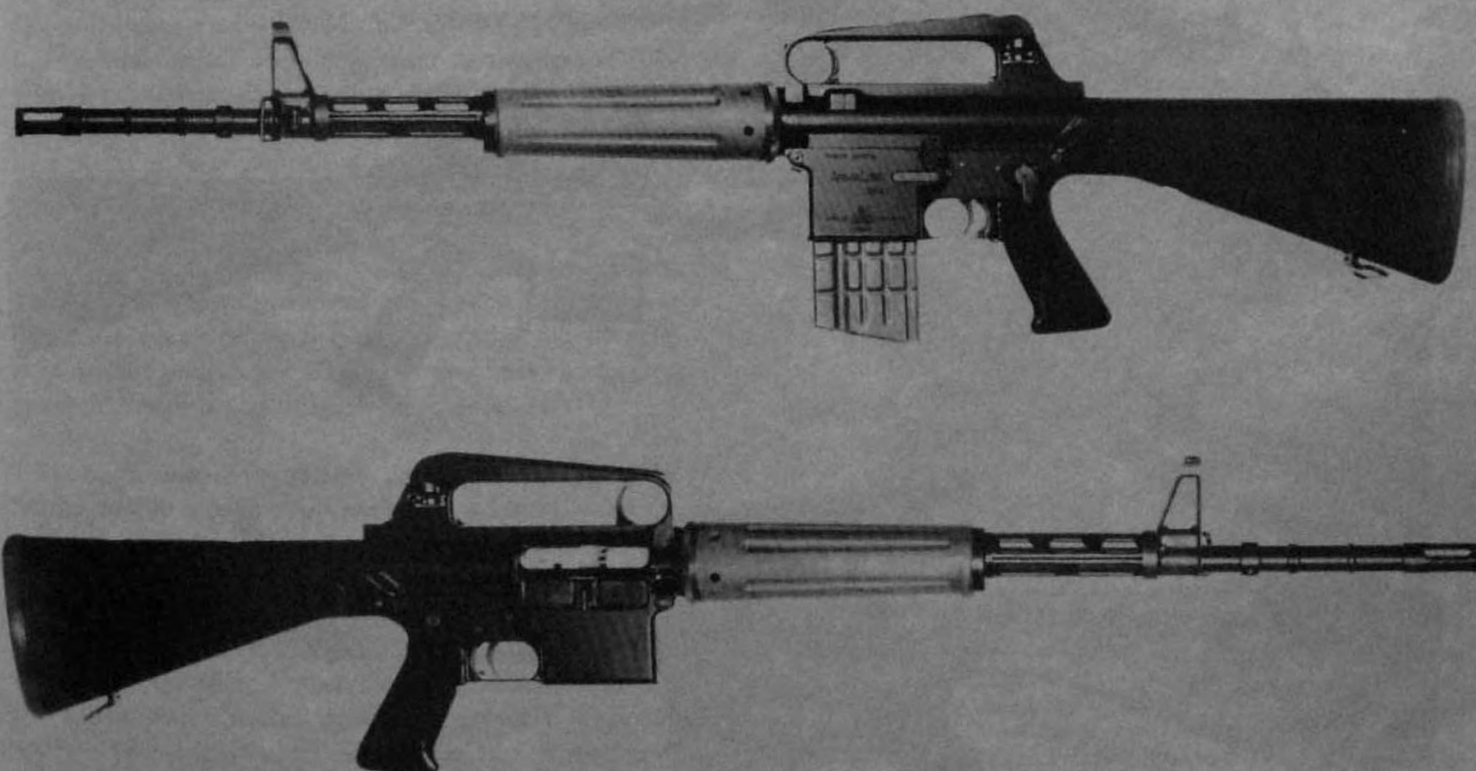
51. Photo from a September, 1958 trial of A-1 AR-10 serial no. 000030, the first and so-called "Cuba" or "Sudan" model, by the 507th Ordnance Detachment (Technical Intelligence), located at Detroit Arsenal in Center Line, Michigan. Note SAFE is still straight up. This model weighed 8 lbs. 6 oz. with full (20 round) magazine.

Detroit Arsenal photo, dated August 11, 1958

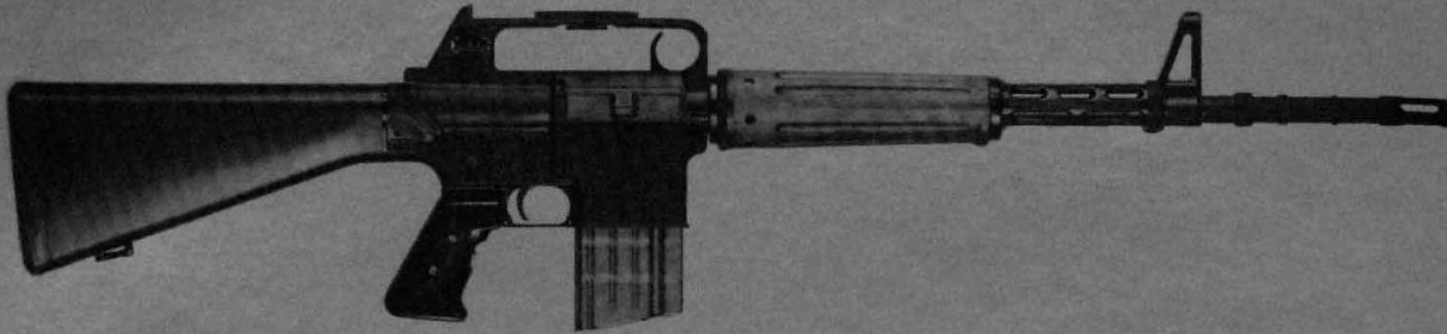
52. Another Detroit Arsenal "Tech n'Tell" photo, showing an exploded view of the early A-1 AR-10 "Sudan" model, right side. Note the fluted steel barrel.

53. AR-10 "Sudan" model serial no. 000030, showing the gas system. Note the gas tube is now positioned on top of the barrel, and the bolt carrier is fitted with a mating "key". The spring-clip dust cover latch has given way to a plunger type. Compare with figs. 39 and 40.

The Artillerie-Inrichtingen "Transitional" Model AR-10



54. Left and right side views of the Dutch second, or "transitional" model AR-10, serial no. 003837. Note the redesigned grenade-launcher/barrel and composite wood-and-stamped-metal forend. The "transitional" model was fitted with a non-fluted barrel, an improved trigger group with an additional trigger spring, a reworked selector lever with SAFE now forward, and a redesigned buffer. Weight: 10.11 pounds fully loaded. In a November, 1960 rain test at Aberdeen Proving Ground, three rifles of this type, serial nos. 004219, 004412 and 004534 firing "Lot FA-14 of Cartridge, Ball, Caliber .30 T104E1", suffered three cartridge case "casualties", wherein portions of the rims were blown off, damaging the extractors and firing pins of two rifles.



55. Right side view of a Dutch "transitional" model AR-10, modified for attachment of a battery-powered infra-red (active) night sight. Note the two-piece pistol grip, held together by two screws, with small front button built in for third-finger activation of the infra-red beam.

56. A pair of consecutively-numbered Dutch transitional AR-10s, with bipods. Above, with bipod open: serial no. 003826. Below, with bipod folded: serial no. 003825.

57. An experimental "shortie" version of the Dutch transitional model AR-10. Note the bayonet lug.

Carving the World into Quarters

As noted, Artillerie-Inrichtingen was licensed to make, but not to sell, the AR-10. Fairchild was so confident of this new program that they divided the world into four different licensing areas for marketing the Dutch-made AR-10. Reserving the US market for itself, Fairchild granted to Sidem International the exclusive sales rights for western Europe and North Africa.

It transpired that Sam Cummings, the president of the International Armament Corporation (Interarmco) of Alexandria, Virginia had seen and fired the AR-10 at one of the celebrated, all-afternoon demonstrations which Fairchild president Richard Boutelle was fond of staging at his well-equipped farm near Hagerstown, Maryland (discussed further in chapter 4).

In comparison with his own FG42, Cummings was impressed with the prototype US-built AR-10: he felt it was the most advanced weapon of its kind he had ever seen. Accordingly, Interarms contracted for and received the AR-10 sales rights to all of South America, all of Africa south of the Sahara, and the Scandinavian countries of Norway, Sweden and Finland.

Exclusive rights to the newly independent countries of ex-colonial Southeast Asia, each with its own quickly awakening postwar defense needs, were reserved for the Baltimore-based agency of Cooper-Macdonald Inc., a name which will figure largely in the story to come.

A Harsh Brush with Reality

Having a source of production, promotional demonstrations of the AR-10 began all over the world. Predictably, interest began to quicken in what the ArmaLite literature promised was the most modern and versatile shoulder rifle available. Unfortunately, however, the program was dogged by mishap. Perhaps this was the combined result of innocent mistakes and the usual "growing pains" in the manufacturing process itself, plus a less-than-perfect knowledge of the fiercely competitive, not to say outrageous, practices which were and still are routinely resorted to in the "smoky back rooms" of the international arms cartels in their quest for a lucrative order.

As an example of the *first* type of problem which Artillerie-Inrichtingen faced, M. Michault recalls that after the Austrian vertical hammer-forge was installed, "The first barrels produced turned out to be highly inaccurate and all the rifles had to be recalled until it was discovered that after the forging process, the barrels had to be stress-relieved.."

The importance of the *second* type of problem facing the fledgling AR-10 is hard to overestimate. A large part of the "political" side of events attendant upon a nation's adoption of a new service rifle consists of behind-the-scenes string-pulling (and worse) where, even as we shall see in the AR-15 story, real and imagined shortcomings of this or that weapon system can, by men dedicated (or otherwise convinced), be magnified out of all proportion to their practical importance. This can, and very often has, sandbagged the very best of weapons.

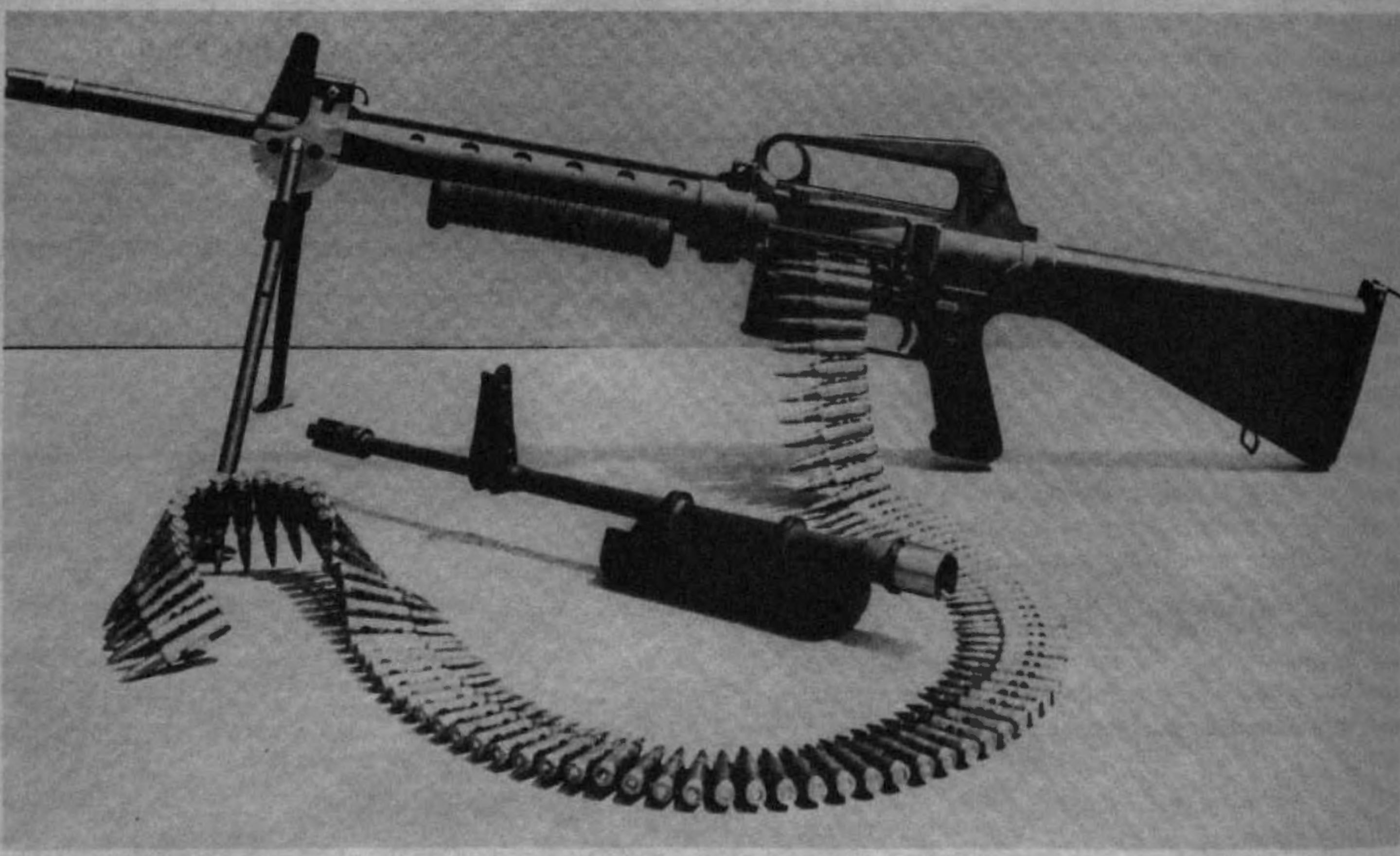
58. The 3x25-power telescopic sight for the Dutch AR-10, manufactured by Delft Optics. Note the knurled, concentric front (windage) and rear (elevation) adjustment rings. The scope is shown fitted to an early transitional rifle, serial no. 003701 (with SAFE still straight up).
From a September, 1959 manual entitled "The AR-10 Infantry Rifle" by Staatsbedrijf Artillerie-Inrichtingen, Hembrug-Zaandam

The Belt-Fed AR-10

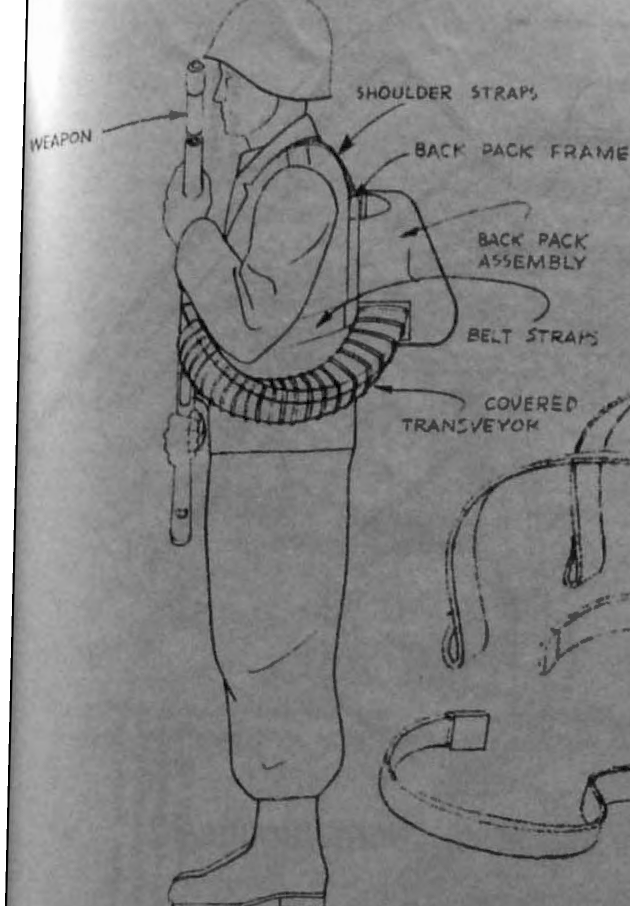
1 AMMUNITION
TRAINING PROGRAM
MAINTENANCE ORGANIZATION
LOGISTICS PROBLEM
in One Basic Infantry Weapon

59. From a later ArmaLite/Fairchild brochure under the heading "Development in Progress" comes first mention of the belt feed concept as adapted to the (US-made) AR-10. Compare with fig. 60: note the absence in this mockup of a "beltway" for ejection of spent links.

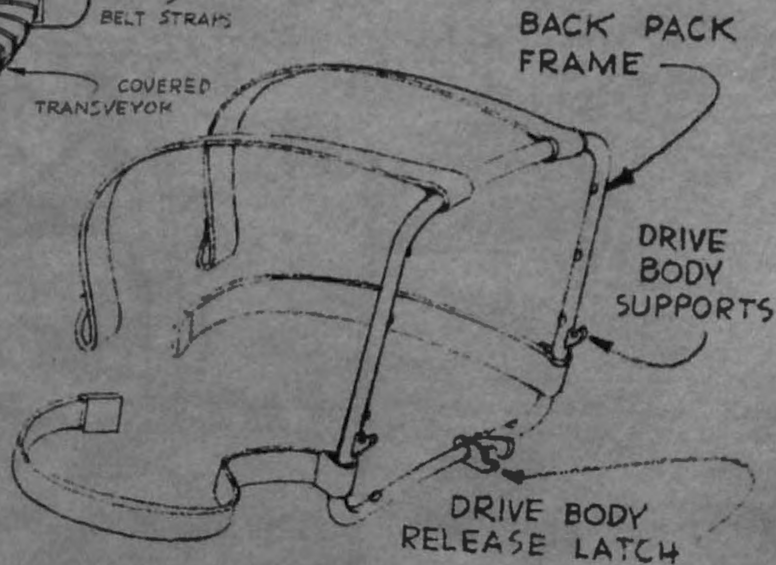
60. Gene Stoner firing an early bipod-mounted, belt feed prototype, built from a Dutch "Sudan" AR-10. Note the non-disintegrating German MG42 belt in its "beltway", cut through the right side of the receiver below the ejection port. The articulated ammunition chute feeds the belt from a modified ammunition can. From the 1957 Fairchild promo film "The ArmaLite AR-10"

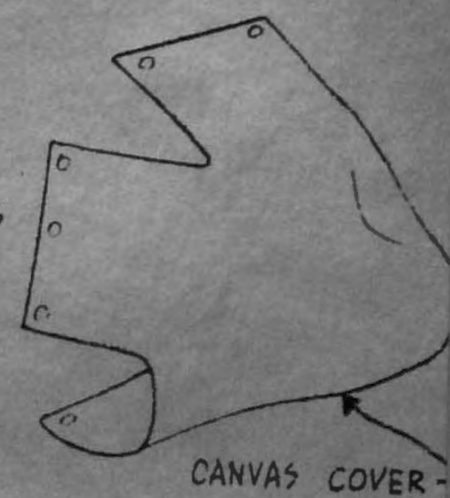


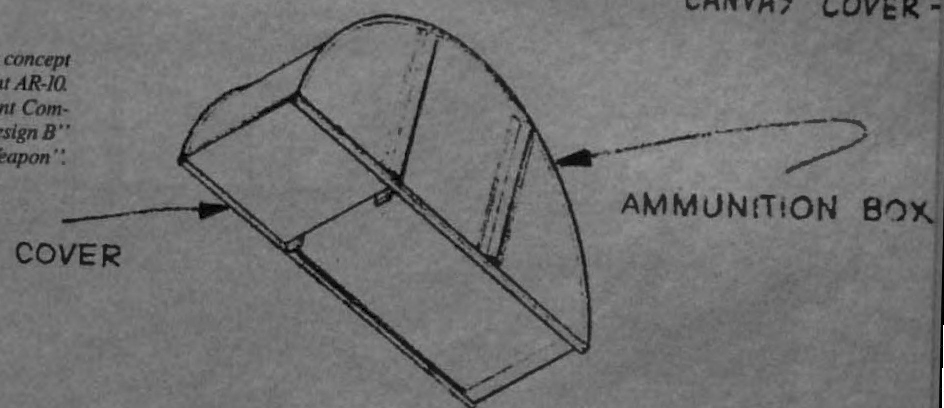
61. A serious approach to sustained fire capability was taken in this Dutch belt feed AR-10, featuring quick-detachable light and heavy barrels, and feeding from a disintegrating-link belt. Note the perforated, half-round upper "handguard", firmly attached to the barrel nut, extending from the receiver. This carries and protects the gas tube, and supports the bipod. A ribbed carrying handle can be seen folded down on the right side of the barrel.



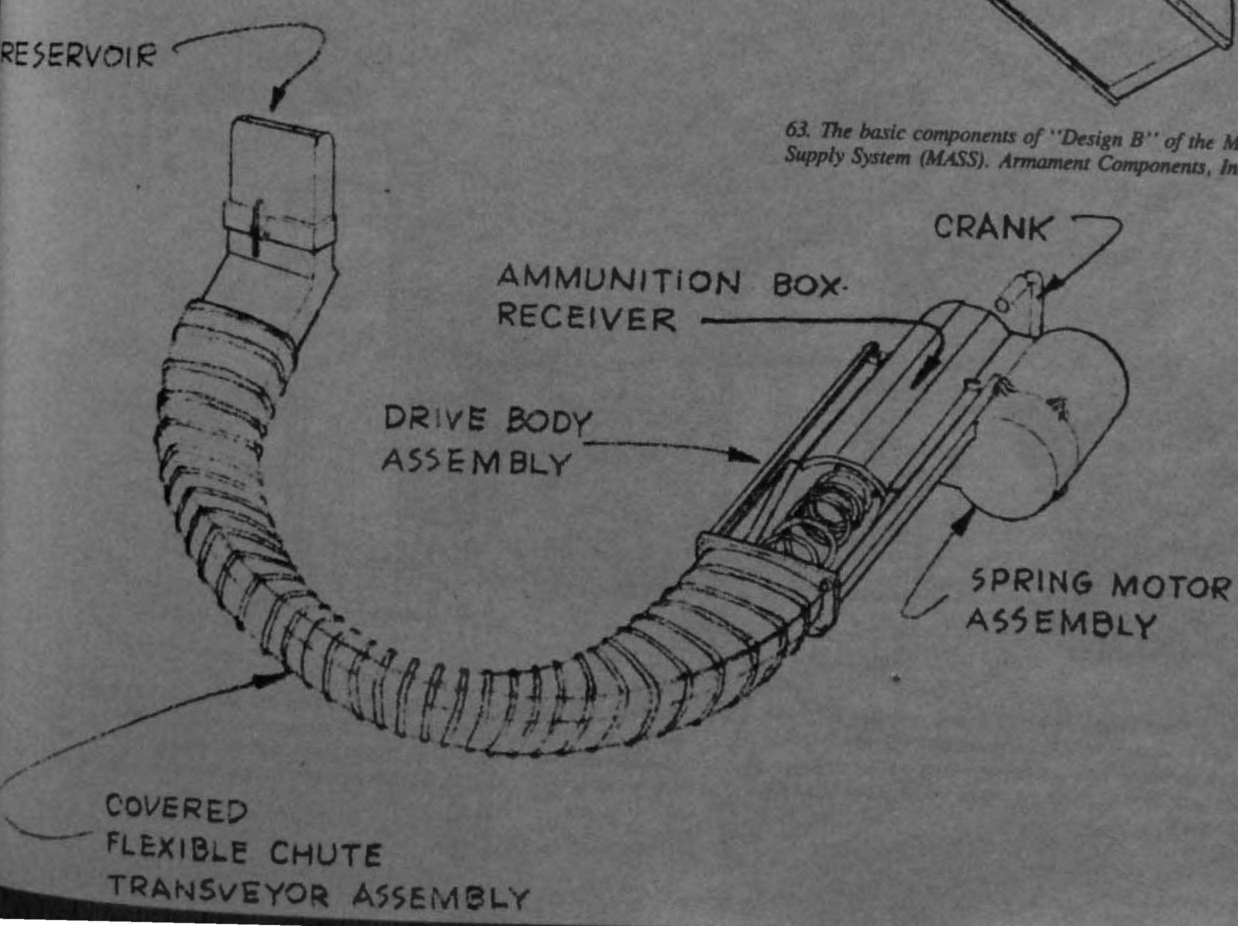
62. *Both ArmaLite and Artillerie-Inrichtingen experimented with the concept of an extended or "backpack" ammunition supply for the lightweight AR-10. Pictured here is the second such proposal from the firm of Armament Components, Inc. of Santa Ana, California dated January 4, 1957, for "Design B" of a "Mechanical Ammunition Supply System for ArmaLite AR-10 Weapon".*

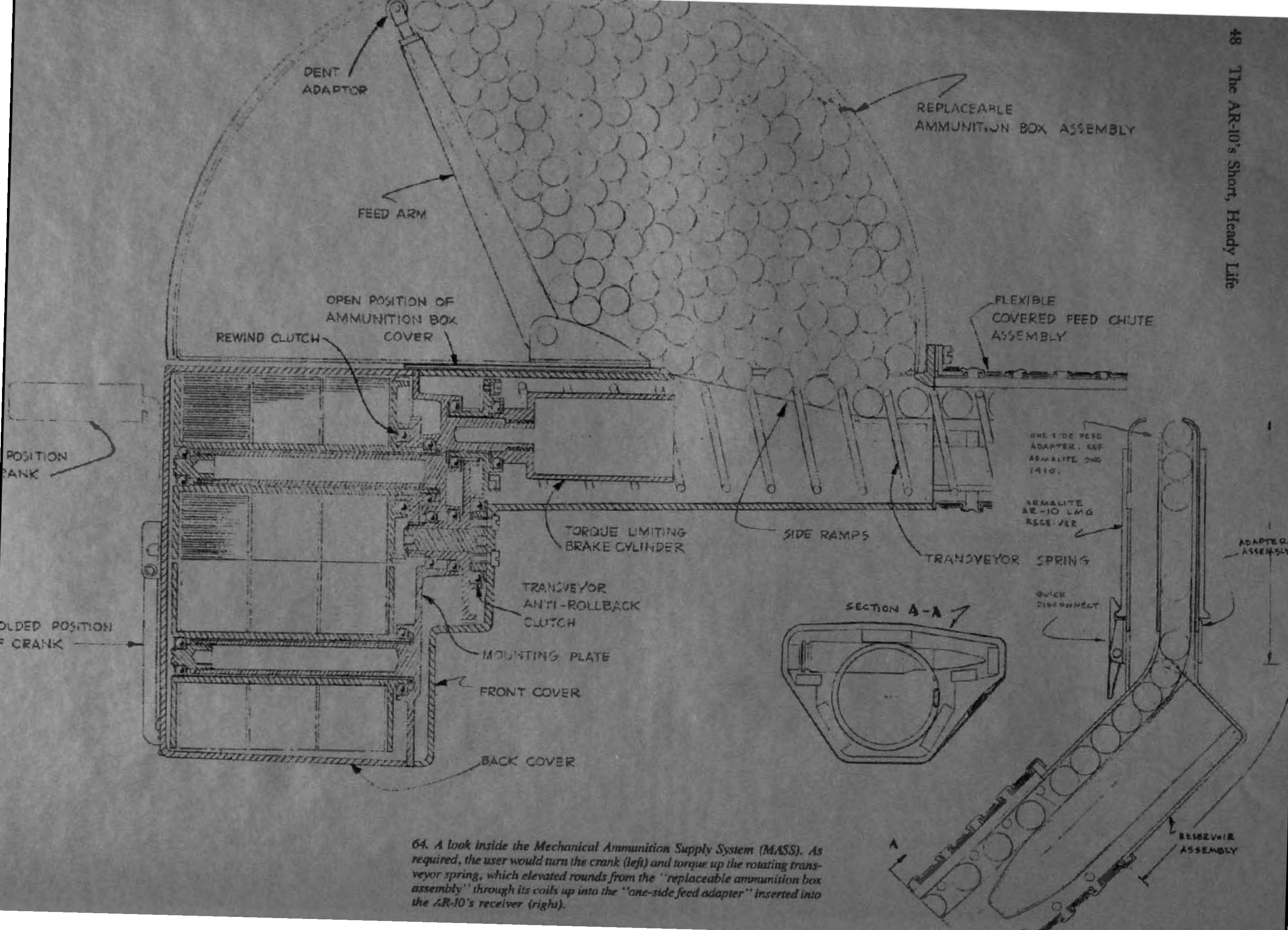




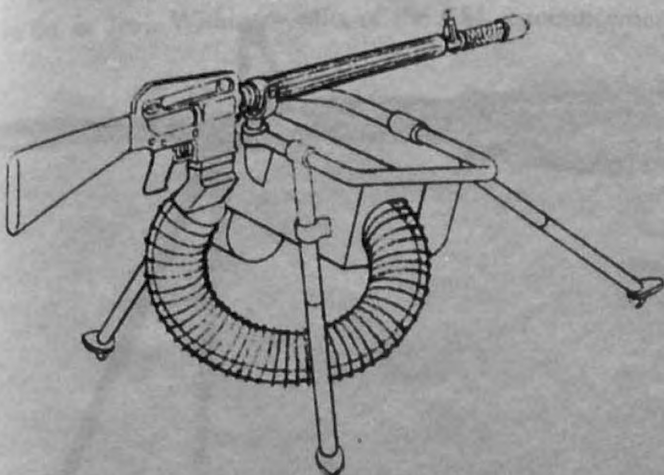


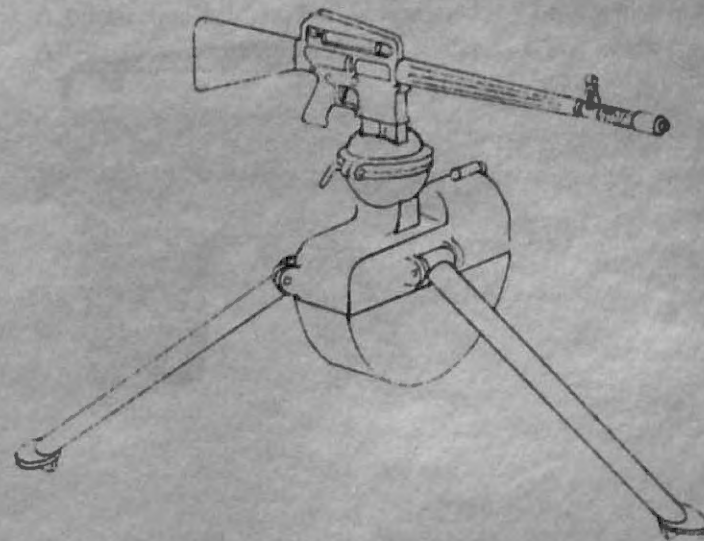
63. *The basic components of "Design B" of the Mechanical Ammunition Supply System (MASS). Armament Components, Inc.*





64. A look inside the Mechanical Ammunition Supply System (MASS). As required, the user would turn the crank (left) and torque up the rotating transveyor spring, which elevated rounds from the "replaceable ammunition box assembly" through its coils up into the "one-side feed adapter" inserted into the AR-10's receiver (right).

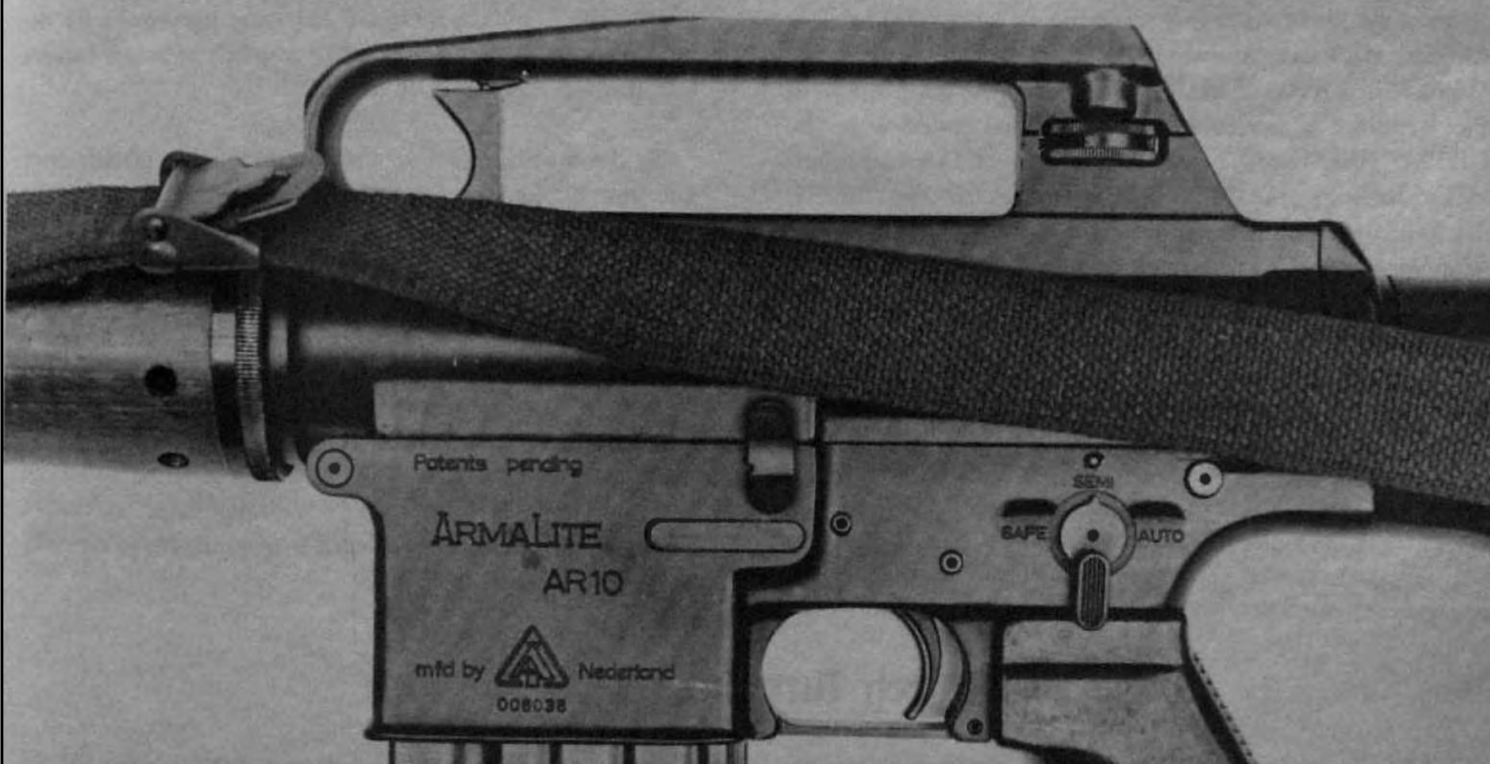




65. Other means of extending a fixed or tripod-mounted AR-10's ammunition supply, as envisaged during the 1957 Armament Components study.

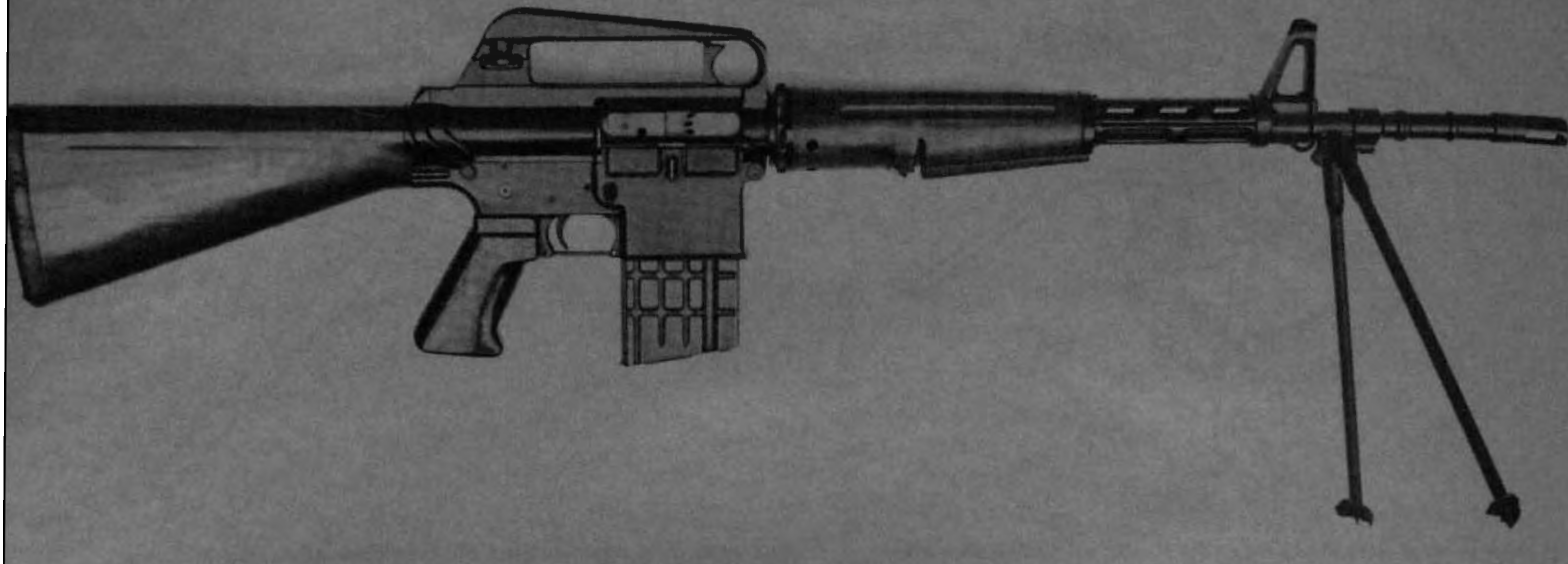
Left, entitled "A tripod-mounted MASS unit and AR-10 weapon". Right, entitled "Combination MASS/tripod unit for AR-10 weapon"

Disappointment in South Africa - the Final "NATO" Model AR-10



66. The final model of the Artillerie-Inrichtingen AR-10, produced for the South African NATO-caliber rifle trials in 1960 and later adopted by Portugal. Serial 006038. The "NATO" or Portuguese model AR-10 features the "transitional" wood half-handguard with its stamped-metal liner protruding up to the gas block, as well as a unique, forward-latched cocking handle. The long, solid bar of the earlier cocking piece (fig. 52) has been done away with and now telescopes within, no longer protruding through the rear of the receiver. Note the solid boss, added to the lower receiver to seal the opening.

Photo credit: Masami Tokoi



67. The final, Dutch-made "NATO" model AR-10, right side view with open bipod. After serial production of less than 6,000 rifles, Artillerie-Inrichtingen abandoned the AR-10 program in 1961 when the Dutch Army adopted the FN FAL rifle. *Photo credit: Masami Tokoi*

Six of the world's newest selective-fire 7.62mm NATO-caliber shoulder rifles were examined and fired during the winter of 1959-60, in a series of trials sponsored by the government of the Republic of South Africa. The arms tested were the CETME (the Spanish heir to late second-war German roller-lock technology); the CETME's new German cousin the G3; the Danish Madsen Light Automatic Rifle (a Kalashnikov adaptation); the FN FAL; a new improved model of the Dutch-made AR-10, built specially for the trials and later known as the "NATO" model (fig. 66); and the Swiss SIG Model 57 Assault Rifle.

Determined to follow their own racial policies in the face of growing world sanction, the South Africans were seeking nothing less than full small arms autonomy with the most modern weaponry available. Therefore, at stake for the winner of these important trials was an on-the-spot contract for an initial 25,000 rifles, plus a lucrative licensing agreement for the manufacture of many times that number at South Africa's state-owned ARMSCOR arsenal.

To the surprise of few, the intrepid forces of Belgium's Fabrique Nationale won out overall in the 1960 South African competition. By this time, of course, the FAL rifle was a five-year veteran of successful quantity production. Aside from the disappointment of the 1957 US adoption of the M14 (itself a study in "politics"), the history of the FN FAL and its licensed inch-measurement and metric copies was one of unbroken successes, wherein the overwhelming majority of the free world's rapidly modernizing armies had adopted the FAL. By comparison, virtually every other entrant in the South African "NATO" trials was barely past the prototype stage. Interestingly, the AR-10 finished second overall, losing out only to the vastly more fully-engineered FAL.

The Dutch Turn Down the AR-10

While certainly no mean feat, placing second in South Africa soon proved to be a left-handed compliment indeed, as FN saw to it that glowing transcripts of the trials results were made available to all prospective arms buyers who were still undecided. Under the weight of such impressive evidence, few defense ministries were inclined to gamble on the *second*-best rifle. Monsieur Michault continues:

> *..In the meantime, tests were going on with the Dutch Army and [Artillerie-Inrichtingen's director Hans] Jungeling was convinced that adoption [of the AR-10] would follow. It turned out that the Dutch Minister of Defense, who had a personal grudge against Jungeling, had secretly entered into an agreement with Fabrique Nationale of Belgium and the news came like a bombshell: the Dutch Army would adopt the FAL rifle.*

As discussed in *The Metric FAL*, this the Dutch proceeded to do, in 1961. Within months of the FAL announcement Artillerie-Inrichtingen had abandoned the production of the AR-10 after total production of less than 6,000 rifles.

Known Purchasers of the Artillerie-Inrichtingen AR-10

Country	Est. Qty	Model/Type/Comment	Sales Agency
Cuba	1	sample - full plastic handguard, fluted barrel	Interarms
Mexico	1	sample	Interarms
Panama	1	sample	Interarms
Venezuela	4-6	sample	Interarms
Nicaragua Nat'l Guard	7,500	These rifles were adopted and ordered, but never delivered. The contract was cancelled when a prototype test rifle blew up during an endurance test.	Interarms
Guatemala	200-500	for the Military Cadet Academy	Interarms
Finland	6-10	special order, in caliber 7.62x39mm	Interarms
Sudan	1,500-1,800	"Cuba" type - full plastic handguard	Interarms
Portugal	800-1,000	"NATO" model, developed for South African trial. Half-handguard with perforated metal front end; latched and telescoping cocking handle; redesigned trigger group.	Sidem

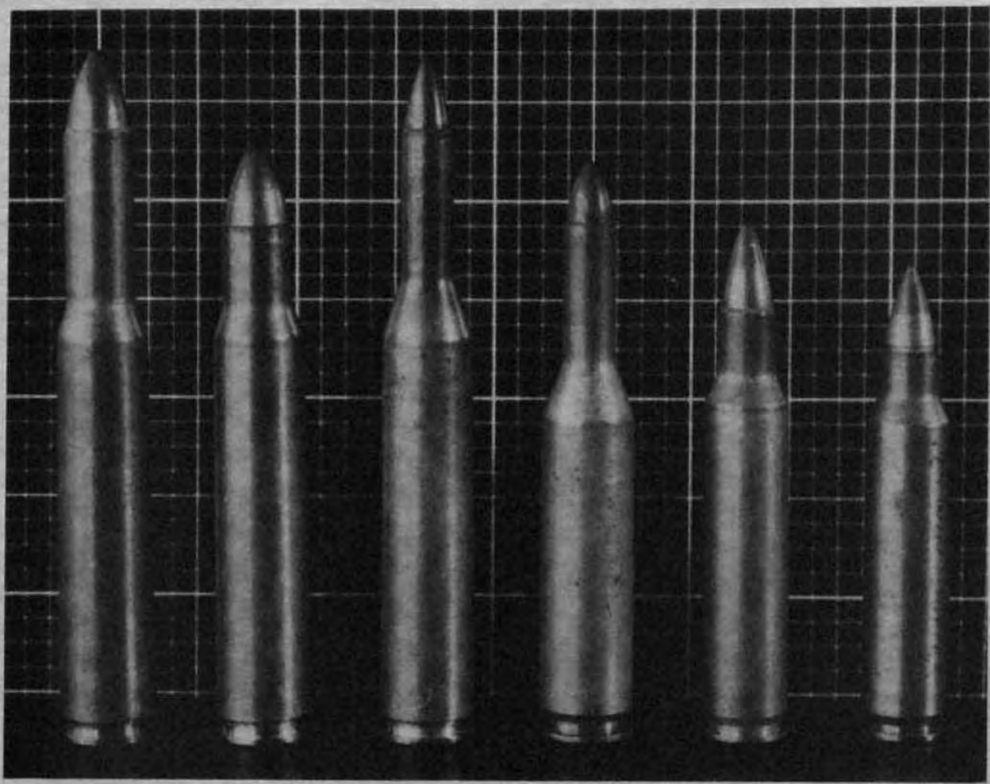
In order to improve the margin of safety when launching grenades, later Artillerie-Inrichtingen barrels were unfluted and thus heavier. The AR-10 now weighed 10.11 lbs. fully loaded.

Meanwhile, back in America, the AR-10 had effectively been superseded by the events described below. In any case it no longer offered any weight advantage over "conventional" rifles like the M14. When the contractual opportunity arose in 1960, Fairchild also withdrew from the arrangement with Artillerie- Inrichtingen.

Chapter Three

THE SCHV CONCEPT COMES OF AGE

The Genesis of the Military 5.56mm Projectile



68. Some of the multiple-bullet rounds tested during Project SALVO. From left (actual size): 1. Long-necked .30M2 Triplex (from the July, 1956 SALVO I trials), with three 66-grain bullets, headstamped WRA 56; 2. Short-necked .30M2 (red-tipped) Triplex from SALVO II, headstamped WRA 57; 3. Long-necked .22/.30M2 Duplex, headstamped WRA 57; 4. Long-necked .22/.30 Light Rifle Duplex, headstamped WCC 54; 5. Green-tipped FAT 127 Duplex, the 2.080" (52mm) long-case version of Dr. Carten's short-lived 6.35mm (.258 caliber) "red herring", headstamped FA 59; 6. Green-tipped FAT115 Duplex, the 1.880" (48mm) short-case version, headstamped WCC 59.

Editors' s collection

As mentioned, the Army had decided to share with Fairchild the outcome of the SALVO I field trials, wherein over the summer of 1956 the latest in Duplex and Triplex loads and flechette shotshells (further discussed in *The SPIW*) had been tested along with two versions of the SCHV concept: the Gustafson .22 Carbine firing a 41-grain bullet at 3,125 fps, and a modified T48 firing a 68-grain .22 caliber bullet from a necked-down caliber .30 Light Rifle case, at 3,400 fps. This latter bullet had been designed at Aberdeen in 1954 by Gustafson and Davis in their quest for the optimum .22 caliber military bullet. Under Project SALVO contracts, trials quantities of these bullets were manufactured by the Sierra Bullet Co. of Whittier, California, to the Aberdeen drawing, and the special cartridge cases were made up by Olin's Winchester/Western Division.

In recent correspondence with the authors, William C. Davis, Jr., today a private professional engineer and consultant, has kindly documented his lengthy involvement in the genesis and development of what became the 5.56x45mm cartridge. Few men were closer to the program and fewer were better qualified to be there, as fewer still possessed Mr. Davis' encyclopedic knowledge of ballistics and his lucid style of reportage.

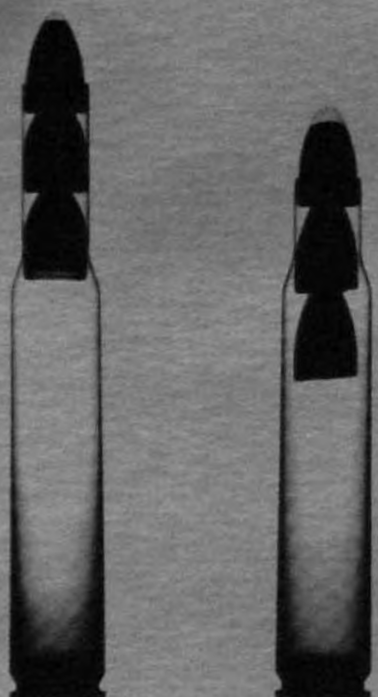
By way of introduction, Mr. Davis hastens to disclaim any status as the "inventor" of the 68-grain, .22 caliber "Sierra" bullet:

..That [68-grain] bullet was hardly a "new design", but was merely a .22-caliber homologue of the caliber .30 M1 ball bullet that had been developed by Army Ordnance during the 1920s for use in long-range machinegun fire..

In any event, it had soon become apparent to Gustafson and Davis that a 41-grain bullet in the .22 Carbine cartridge was "too little", and the 68-grain "Sierra" bullet in the necked-down .30 Light Rifle case was "too much":

..Accordingly, we had drafted a letter to [the Office, Chief of Ordnance] some time in 1955, proposing a .22-caliber cartridge, employing a boattail bullet of approximately 55 grains weight, at a muzzle velocity of approximately 3,300 fps, for use in a rifle substantially lighter than the T44/M14. We had also proposed a program to design such a cartridge at Aberdeen, build one experimental automatic "test fixture" (rifle) to fire it, and requested one-year funding authorization in amount $60,000 for this project..

A Note About "Mission Responsibility"



69. Actual-size, X-ray photographs of .30M2 Triplex rounds nos. 1 and 2, above, showing the canted bases on the nested second and third bullets (round no. 2). Photo courtesy Capt. William Etter

By long-established tradition, the specialist responsibilities and duties attendant on the development of US small arms weapons and ammunition had been apportioned out to three basic Ordnance agencies. Springfield Armory was in charge of the engineering design of the actual weapons, while Frankford Arsenal had similar responsibilities with regard to the ammunition. Aberdeen's Development and Proof Services was charged with the engineering testing and evaluation of both ammunition and weaponry. With this in mind, Mr. Davis notes:

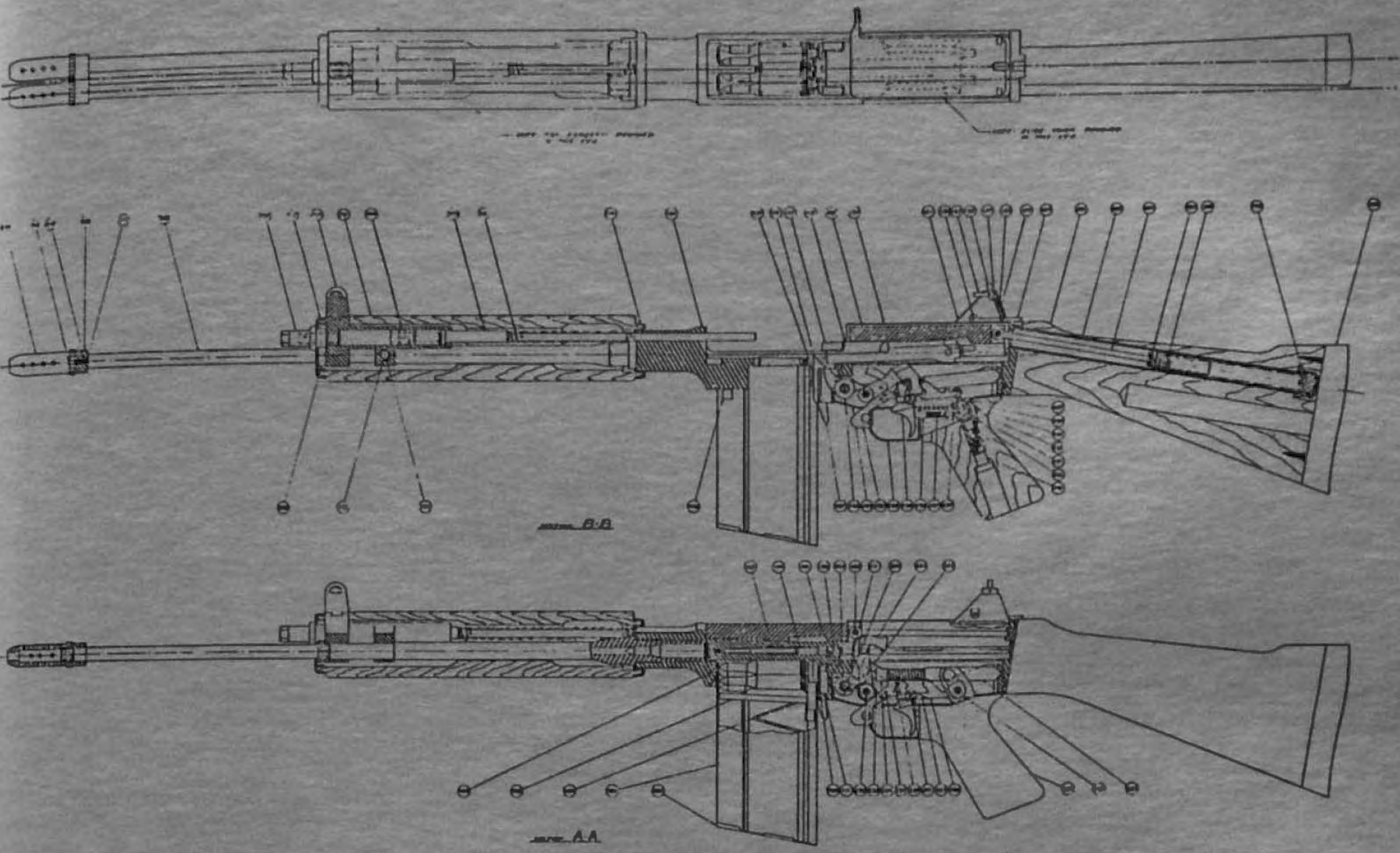
We recognized, incidentally, that this proposal was in fact quite outside our officially assigned mission responsibilities, encroaching on [those] of both Frankford Arsenal and Springfield Armory...We had, however, had some success in gaining approval..for our previous exploratory work [on the .22 Carbine], and we hoped that this indulgence might continue. Our letter, which was classified CONFIDENTIAL, was accordingly prepared for the signature of Mr. T. F. Colleran, then Director of the D&PS at Aberdeen, and sent forward some time in 1955.

Dr. Carten's First Denial

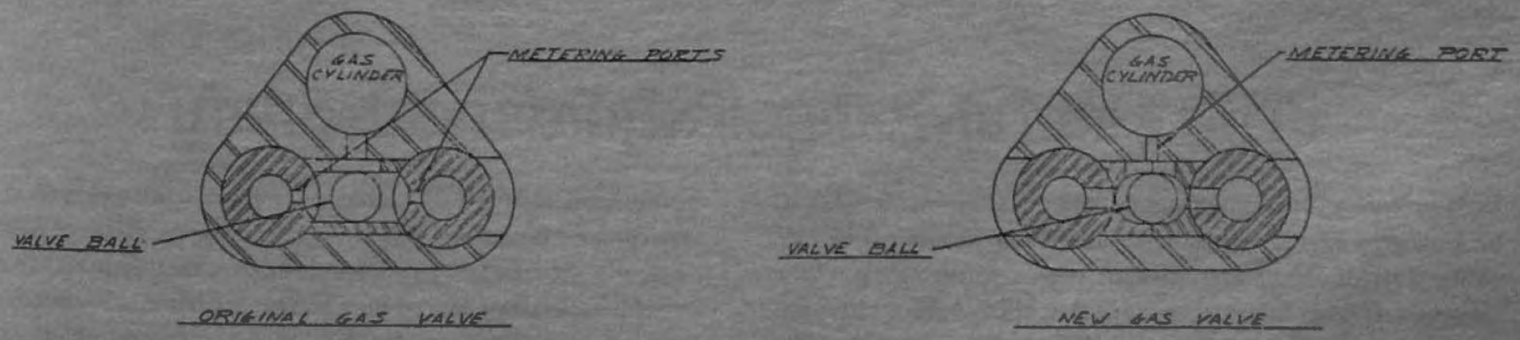
Frederick H. Carten, Ph.D., had been Col. Studler's civilian executive for some years before the latter's retirement in 1953. Bill Davis describes Col. Studler as "above all, a consummate pragmatist in matters of policy; he believed very sincerely that the attainment of a worthy goal would justify whatever means might be necessary to attain it". As for Dr. Carten, he was "a distinguished technical expert in his own right, but nevertheless a protégé of Col. Studler, and his views in matters of policy were virtually the same as those of Col. Studler".

Known later as "the father of the M14", Dr. Carten was a staunch advocate of the OCO-sponsored T44 Light Rifle and its "full-power" cartridge, the 7.62mm NATO round. Recognizing the growing threat which the audacious SCHV concepts presented to his infant M14 procurement program, Dr. Carten did everything in his power to undermine and terminate any official consideration of them.

It therefore comes as no surprise that no written response was ever received to Aberdeen's confidential request for continued SCHV funding. Mr. Davis recalls that they were notified verbally by Dr. Carten that the request was denied, for the very valid reason that the activity proposed was not within Aberdeen's mission responsibility, and that the objectivity of D&PS as a test agency might be "compromised" by any further direct participation in materiel design.



70. An interesting Winchester two-barreled SALVO idea called "SALVO Rifle Cal. .22 T65 Duplex", which appears to have been built upon two T48 (FAL) rifle actions. Winchester/Western contract dates February, 1956 to December, 1957.

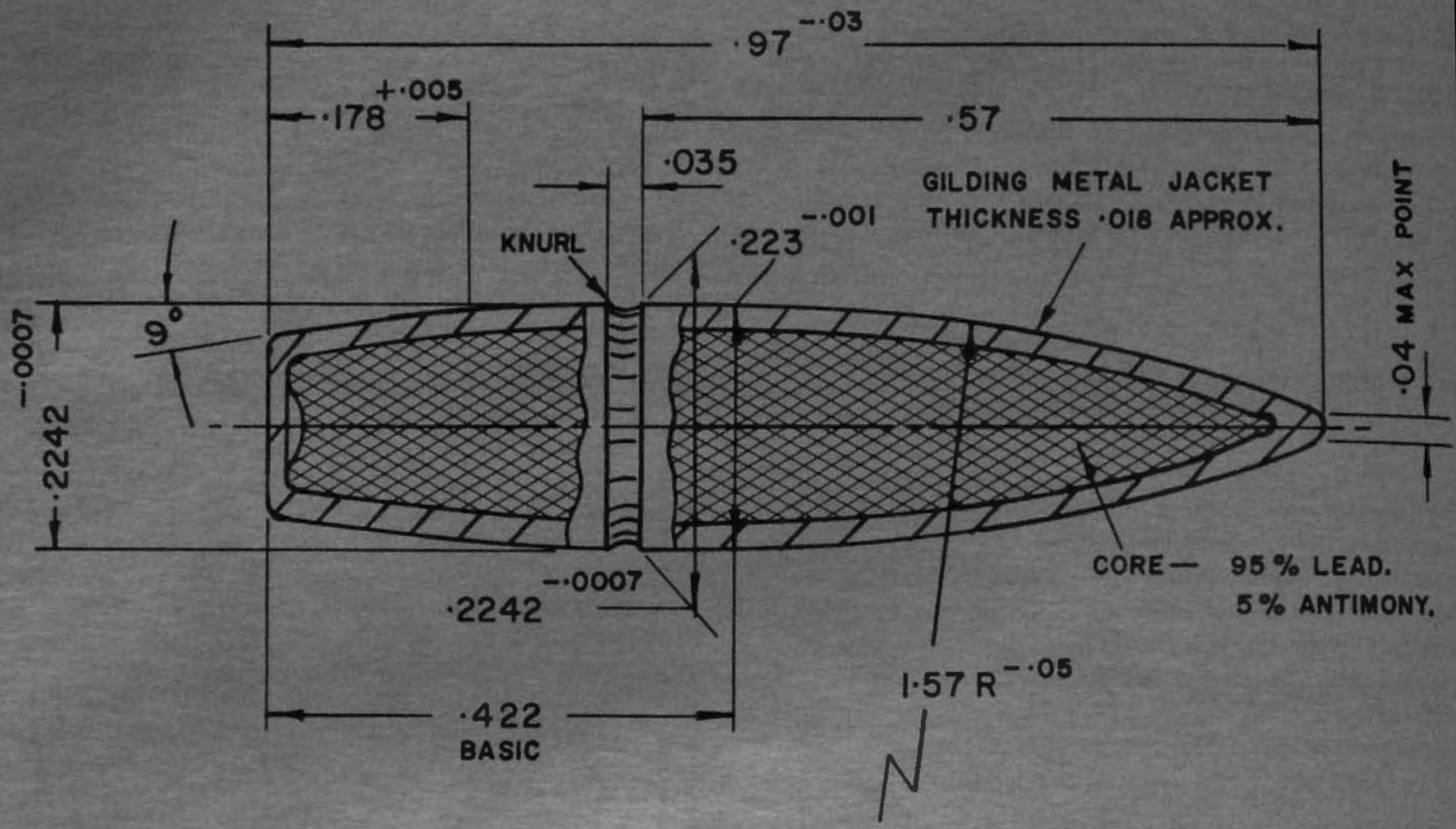


71. Front view of the gas block of the Winchester ".22 T65 Duplex" SALVO rifle, showing the ingenious method of activating the single gas piston from either barrel.

From Aberdeen to ArmaLite, via a Circuitous Route

In February of 1957, against a background of the imminent adoption of the M14, Fairchild's General Devers paid a visit to the Office Chief of Ordnance to pour a little oil on the troubled wake of the just-concluded and rather disastrous Springfield Armory trial of AR-10 serial no. 1002. He also asked for, and received, Fairchild's first official briefing on the results of the SALVO I SCHV ammunition trials.

Meanwhile, CONARC's Commanding General Willard G. Wyman had been most impressed with the ArmaLite concepts which he had witnessed at the 1956 demonstration of AR-10 prototypes at Fort Monroe. In discussions with Gene Stoner, General Wyman explained that the Infantry Board, in following the recommendations of previous SCHV research, were essentially looking for a .22 caliber rifle with a respectable



72. The celebrated 68-grain "Sierra" bullet, homologous to the long-range caliber .30 M1 machine gun bullet of the nineteen twenties, designed at Aberdeen Proving Ground in 1954 and featuring a 7-caliber tangent radius and a 9° boattail. *Redrawn by Thomas B. Dugelby*

hit probability out to 300 yards. As fate would have it, a copy of the Aberdeen letter requesting funding for and describing the proposed D&PS development of the optimum 55-grain .22 bullet, which Dr. Carten had denied, had somehow found its way into General Wyman's possession, where as Bill Davis notes it "served some useful purpose in formulating the requirements that were given to Gene Stoner.."

The Fateful Range-Requirement Snafu

On General Wyman's recommendation, the Infantry Board submitted a formal request for the development of a new SCHV rifle. The Board themselves had been sold on 300 yards as a practical combat range, but felt that CONARC, politically, would look more favorably on a 400-yard requirement. The decision at Fort Monroe was that 500 yards sounded like a rounder, easier number to pass muster at the Pentagon. Accordingly, the requirement was finally "cast in concrete" for a six-pound, selective fire .22 caliber weapon, conventionally stocked, holding 20 rounds or better. Significantly, the cartridge itself was not specified, for the simple reason that there wasn't a totally satisfactory one yet in existence, but it had to be powerful enough to penetrate a steel helmet, body armor or 10-gauge (.135") steel with trajectory and accuracy equal to or better than the M1 rifle, and wounding power equal to or better than the .30 Carbine, all out to 500 yards.

The First ArmaLite SCHV Weapon - the .222 "Stopette"

The first design ArmaLite presented, apparently in response to the original 300-yard range criteria, was a short-lived creation by the designer of the AR-5 called the "Stopette". It had the required conventional stock, and was chambered for the standard commercial .222 Remington cartridge. A few preliminary tests revealed that a lightweight arm of this type combining a drop-heel, foam-filled fiberglass stock with a rather high cyclic rate, resulted in unacceptable climb. Important lessons had been learned about climb and controllability in the AR-10 program: so much so that the decision was taken at Fairchild to produce an AR-10 "lookalike" to fire the .222 Remington round.

73. Fig. 105 from US Rifle M14, *showing the old M1, right, and the new 7.62mm NATO M14, officially adopted on May 1, 1957.* *US Army photo*

ArmaLite's "Scaled-Down" AR-10

In private conversation Gene Stoner has always admitted that his prime interest has been in developing rifles in 7.62mm NATO caliber. Indeed, at Fairchild's behest he had by this time designed the AR-16, expressly with a view to licensed production in less developed countries where the technology to produce screw-machine parts and weld them to plain carbon steel stampings made much more sense than did expensive aluminum alloy forgings. In addition, it appears that Stoner saw little military potential in the .222 Remington round. Accordingly, the complex job of developing the "scaled-down" AR-10 went to two engineers in ArmaLite's employ at that time, Robert Fremont, Stoner's chief design assistant, and the mentioned L. James Sullivan, who had first prepared the toleranced production drawings for the AR-10 wherein the gas system had been repositioned to the top of the barrel.

Actually, the term "scaled down" is far too simplistic a description for the process which produced the AR-15 from the AR-10. For one thing, all the parameters did not fit the same "scale". A scale based solely on comparative weights and sizes of the two cartridges, for example, would indicate a rifle dramatically lighter and smaller than its NATO forebear. Other factors were comparatively much nearer being equal, with the chamber pressure of the finalized M193 5.56mm cartridge actually 2,000 psi *higher* than the (50,000 psi) average for M80 ball.

When the new rifle was tested with commercial .222 Remington ammunition, the in-line stock and heavier recoiling parts of the new rifle, plus a somewhat lower rate of fire, kept it so impressively "on target" that Stoner's subsequent short demonstration before General Wyman led to a business arrangement being made virtually on the spot. CONARC's request to the Army Adjutant General for ten of these new ArmaLite rifles for Infantry Board trial was dated May 6th, five days after the announcement of the adoption of the M14.

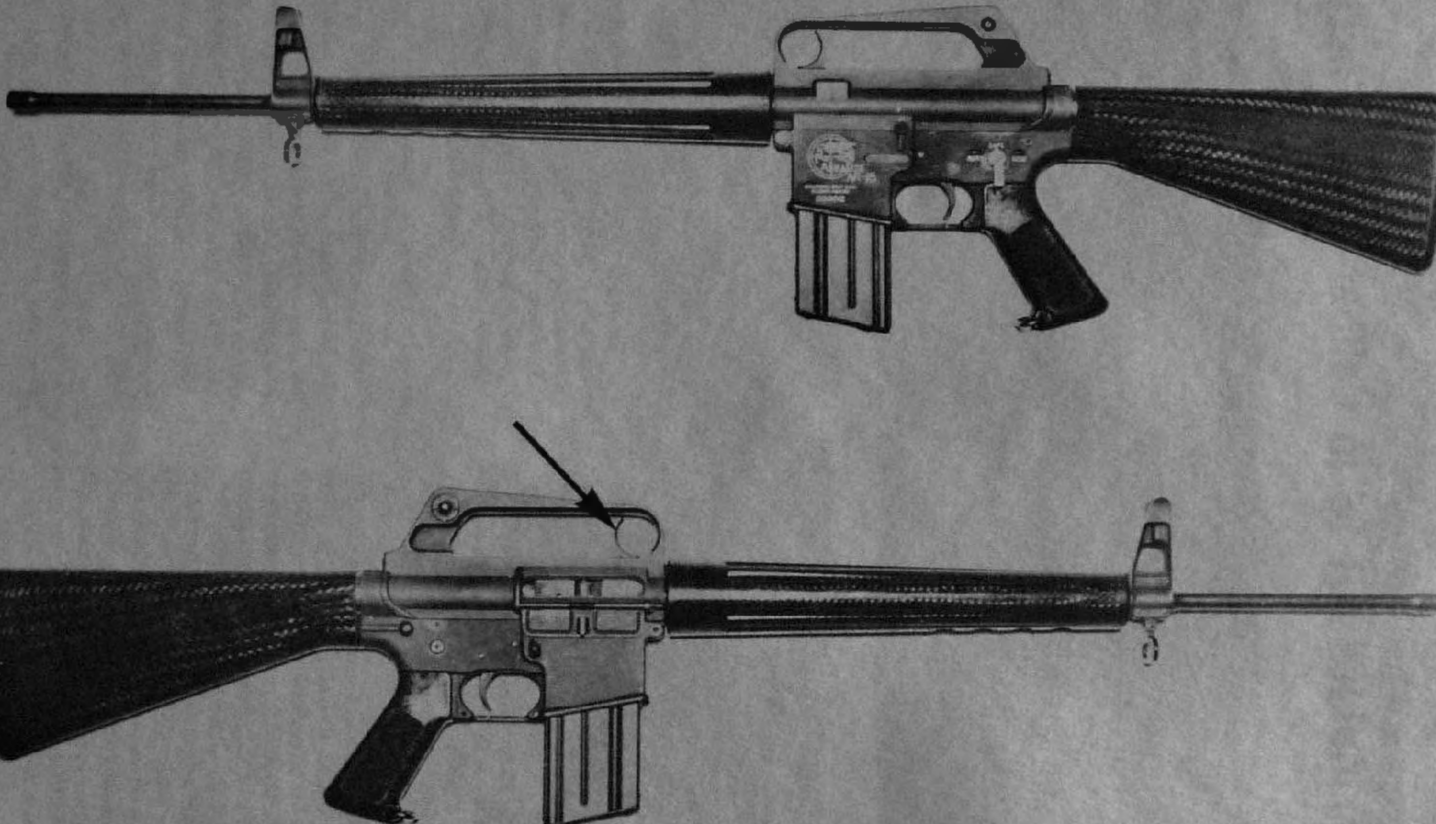
74. A very early appearance of one of the first 17 ArmaLite AR-15s. The caption reads: "On the rifle range, Maj. Eugene M. Lynch instructs Lt. Col. Robert Vallendorf on how to fire the new ArmaLite AR-10 [!] rifle now being developed by the Combat Developments Experimentation Center". Note the plain muzzle and absence of a bayonet lug; the one-piece, cylindrical fiberglass handguard; the AR-10-style cocking handle and 25-round magazine.

US Army photo dated March 31, 1958, courtesy Daniel D. Musgrave

Thus, with the AR-10 itself officially out of the running as the next US rifle, but locked into what Fairchild hoped would be a proud new worldwide manufacturing arrangement with Artillerie-Inrichtingen, the focus of ArmaLite's attentions turned to the .222 caliber rifle, soon dubbed the AR-15. The fateful genesis of this project, with its cavalier setting of requirements and freedom of ammunition choice, was a model of informality in sharp contrast to the ponderous rigidity of the Ordnance Corps' own .30 caliber Light Rifle program. There were advantages and disadvantages inherent in each of these methods of development, as time was to make amply evident.

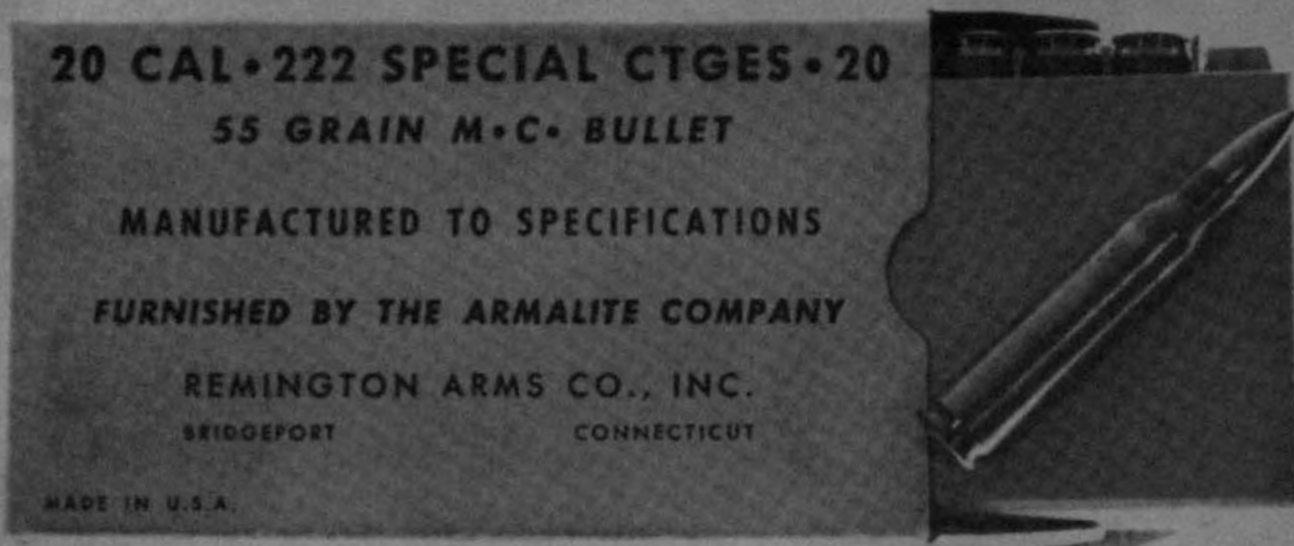
General Wyman's request was approved, and the Chief of Ordnance was directed to procure ten .222 caliber ArmaLite rifles and 100,000 rounds of ammunition. It appears that ArmaLite actually made up a total of seventeen such rifles.

Engineers Fremont and Sullivan made some further modifications before ArmaLite produced these first AR-15s. Taking advantage of the flat-shooting .222 cartridge, a less expensive two-position "L" peep sight was fitted into the rear of the carrying handle portion of the aluminum upper receiver, still adjustable for windage but without the click-adjust elevation wheel of the AR-10. Elevation adjustment on the AR-15 was to be accomplished by means of a threaded front post. The rifle itself was 37 1/2" overall, with a 20" steel barrel fluted under the handguard, weighing exactly 6 lbs. with 20 rounds of ammunition (6.12 lbs. with a full load of 25 rounds). Abandoning once and for all the original Sullivan/Michault trademark of filling the furniture with plastic foam, the straight stock and one-piece, cylindrical handguard were simply hollow, fiberglass-reinforced plastic shells, the latter lined with a thin aluminum heat reflector.



75. Left and right side views of ArmaLite AR-15 serial no. 000012, one of the few of the first series of 17 rifles to remain unmodified. As above, note the plain muzzle, one-piece cylindrical handguard, and AR-10-style cocking handle. SAFE is again straight up, as on the early US and Dutch AR-10s.

The ArmaLite AR-15 in Caliber ".222 Special"



76. Box and sample cartridge of Remington's ".222 Special", loaded under contract for Armalite. Note the Remington 55-grain bullet (fig. 141, no. 2).
Bob Miller collection, photo by Roy Arnold

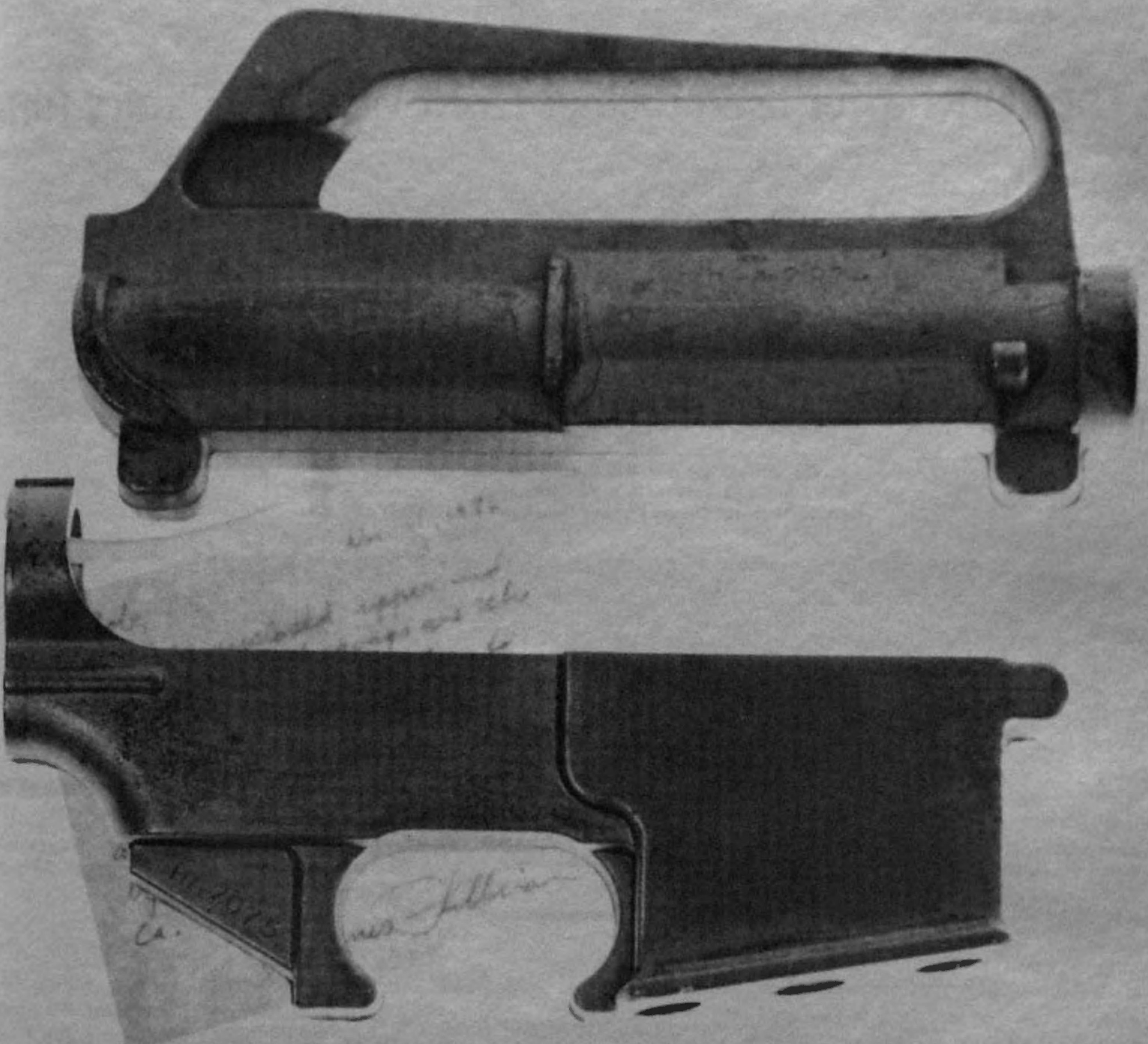
The last change made was of much more import. Due to the surprise increase in the Infantry Board's specified penetration and trajectory requirements from 300 to 500 yards, ArmaLite was forced to modify the .222 Remington cartridge. In Gene Stoner's personal, handwritten historical summary of these early events, he described this process as follows:

> *The cartridge development for the .223 was started by myself in 1957 after a trip to Fort Benning to get the desired military characteristics. I calculated the needed bullet weight and muzzle velocity. I then designed the bullet and had it manufactured by the Sierra Bullet Co. in Whittier, California. This bullet was a 55-grain boattail design with a jacket thickness of .018 inches. The powder finally selected was a standard commercial type.*
>
> *The chamber pressures for this round in the standard .222 case were a little excessive. The obvious conclusion was to increase the case capacity and to use a different powder. I contacted Winchester and Remington about loading the necessary rounds for the test program...The ArmaLite rounds [were] loaded by Remington, with the bullets furnished.. [and] were designated the ".222 Special".*

Gene Stoner is, in the opinion of many, the most gifted firearms designer since John M. Browning. However, in 1958 he was not, nor indeed has he ever claimed to be, an expert in ammunition design or ballistics. In designing his bullet, therefore, he quite rightly took full advantage of the work already done at Aberdeen. On the original ArmaLite drawing of the "Stoner" bullet, the 7-caliber ogive and 9-degree boattail are identical to the earlier D&PS 68-grain M1 "homologue". The only changes made by Stoner were a shortening of the boattail and the cylindrical bearing length of the bullet to reduce its weight in conformance with the 55-grain specification; itself the last legacy of the informal Aberdeen SCHV program which Dr. Carten had scotched.

Stoner personally delivered the first 10 completed AR-15s, and 100 magazines, to Fort Benning in March of 1958. Four were reserved for an extensive Infantry Board field trial, where they were pitted against shiny new T44E4s from Springfield's recently completed "simulated mass production" run of 500 rifles. Three of the remaining AR-15s were apportioned out as demonstrators to other stations, while the final three were earmarked for Fort Greely, Alaska, where they were to be further examined and shot under Arctic conditions.

Stoner remained in attendance throughout the Infantry Board trial. In his words,



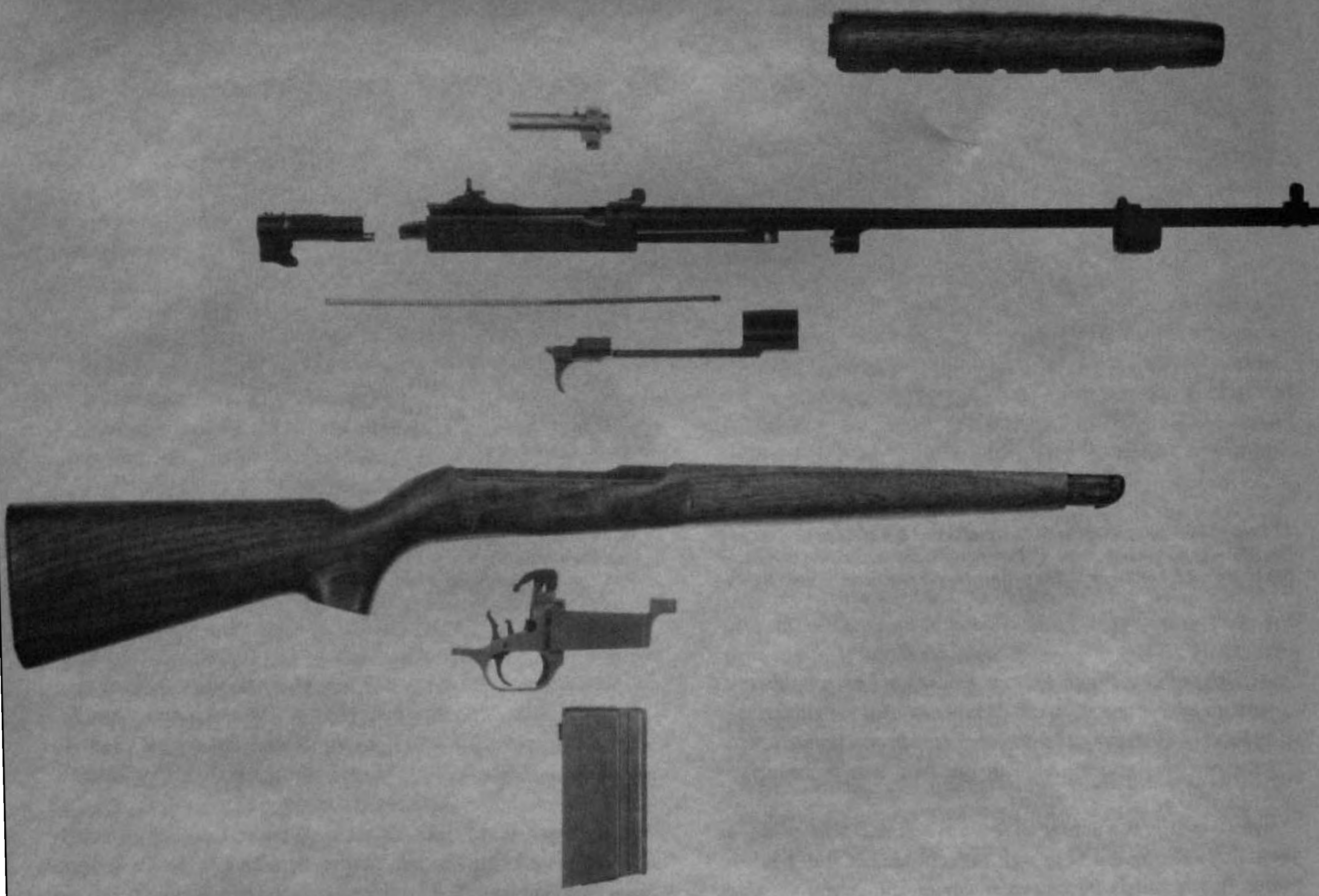
77. Unmachined examples of the earliest production run of AR-15 receiver forgings. The note underneath, from AR-15 designer L. James Sullivan to collector Bob Miller, reads as follows: "..The enclosed upper and lower receiver forgings are the first type from a run of 40 sets, ordered in 1959 from the Harvey Aluminum Company of Torrance, Ca." Note the die mark and serial number "HA 7075" on the lower receiver tang. Bob Miller collection, photo by Roy Arnold

> *..This policy was agreed upon beforehand because there were no instruction manuals or any material for guidance on these new weapons. I also conducted instruction classes until everyone concerned with the tests was thoroughly familiar with the weapon. I was also consulted [regarding any] repairs or parts to be replaced. This procedure proved to be of great value to both the Board and myself, and a great deal of valuable information was gained first hand.*

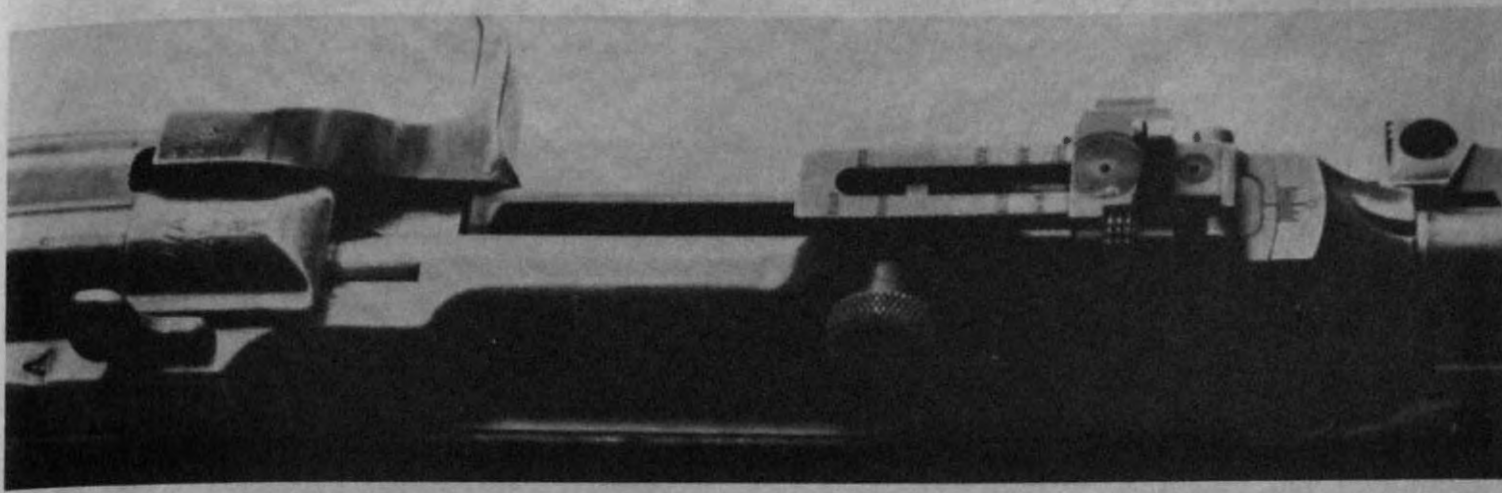
Stoner recalls the actual trials with considerable pride, as these first AR-15s did very well indeed against the T44E4s, which in his words had been made at the Armory "with tender loving care..they were excellent control weapons." He found the combat firing phase "as rugged a test condition as I had ever seen..barbed wire strung within 6 inches of the ground, good and tight, where a rifleman has to go through these obstacles and he can't baby the rifle if he wants to keep any skin on himself...The troopers that were firing, at the end of the day, didn't have any clothes left on them to amount to anything, and their boots were all torn up in a matter of a few days."

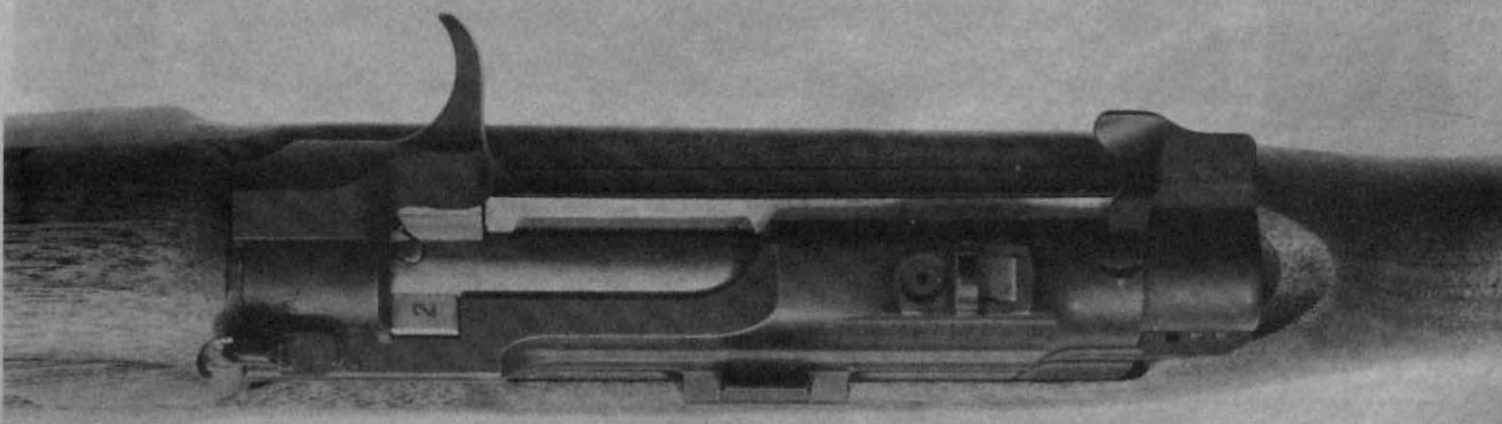
The Winchester .224 Caliber Light Weight Military Rifle

78. The wood-stocked, 5-lb. Winchester caliber .224 Light Weight Military Rifle serial no. 2, designed by Ralph Clarkson and first presented in 1957. Photo: Winchester/Western Research Department, New Haven, Connecticut



79. Winchester Light Weight Military Rifle serial no. 2, disassembled. The resemblance to the M2 Carbine, especially in the bolt, operating slide and short-stroke gas piston, is unmistakeable.





80. Above: action closeup of the World War II Winchester Automatic Rifle (WAR), designed by Marshall "Carbine" Williams. Caliber .30-06, serial no. 8. Springfield Armory NHS

Below: action closeup of Winchester .224 Light Weight Military Rifle, serial no. 2. Note the similarities in safety catch and change lever design, both of which vary from the pattern of the M2 Carbine.

Meanwhile, to the consternation of Fairchild's board of directors, ArmaLite was not alone in the development of a new SCHV rifle. Back in the summer of 1956, CONARC had also invited the Winchester-Western Division of the Olin Mathieson Chemical Corporation to submit an SCHV rifle design of their devising, for competitive trial along with the ArmaLite entry. Winchester lost no time in coming up with a sleek little rifle, weighing only five pounds with an empty 20-shot magazine, and a fluted steel barrel like the AR-10. It featured a conventional walnut stock and handguard, and a short-stroke gas tappet system operating a turning, two-lugged bolt. In these and many other details it resembled nothing so much as an improved M2 Carbine, but significantly, great pains were taken in the Winchester literature to describe the new arm's lineage *without* reference to the disgraced Carbine itself:

> *..From the very beginning of the development work on this weapon it was considered of utmost importance that reliability must not be sacrificed to obtain low weight. As a consequence a policy decision was taken that the new Lightweight Rifle was to be designed on the basis of well proven earlier guns whose field reliability had been established in extensive tests. As a result the best elements were taken from the Winchester .30 caliber Experimental Light Rifle, the G30R Semi-Automatic Rifle, the WAR Automatic Rifle and the .50 caliber Semi-Automatic Anti-Tank Gun, to serve as a basis for development of the Winchester Lightweight Rifle. Thus the locking system..is essentially the same as that of the .30 caliber Winchester WAR Automatic Rifle which has successfully passed extensive field tests carried out by the Army and the Marine Corps. The short stroke gas system is derived from a type successfully used on several proven guns, while the trigger mechanism again is based on the WAR..which also had successfully passed military tests. The bolt design is based on the WAR and G30R rifles.*

Designed by Ralph Clarkson, the first Winchester Light Weight Military Rifle prototype was successfully demonstrated at CONARC headquarters on October 25, and at Fort Benning on November 6, 1957. Winchester/Western had also been given

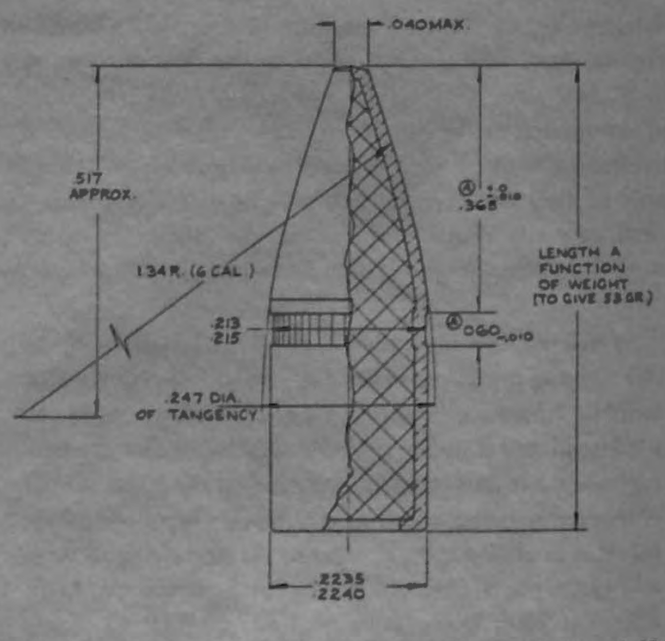
a relatively free hand in the cartridge design, the only specified criteria apparently being a .22 centerfire cartridge capable of propelling a 50 to 55 grain bullet at 3,300 fps. The resulting round was called the .224 Winchester.

81. Top, side, rear and bottom views of the magazine from Winchester's .224 caliber Light Weight Military Rifle, serial no. 12.

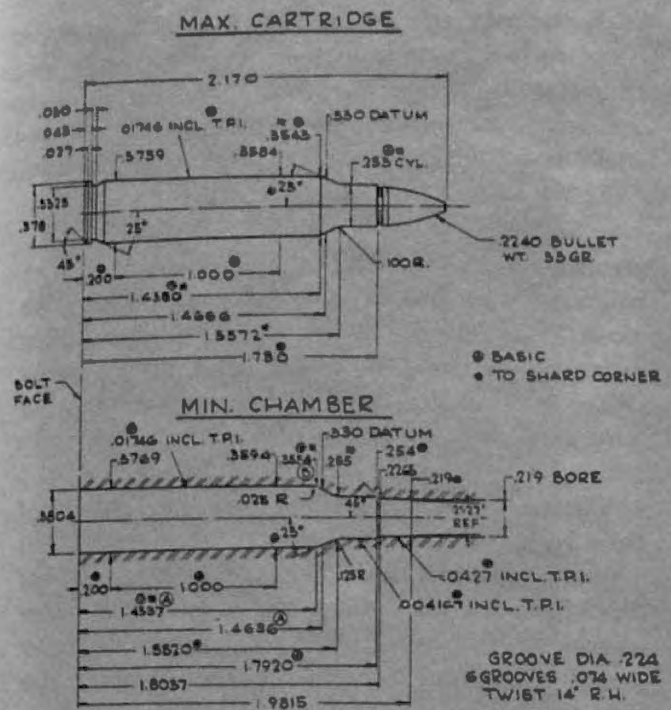
Winchester Runs Afoul of the Increased Range Requirement

The prototype of the Winchester .224 Light Rifle had been ready a few months before the first AR-15s. However, in their determination to "get the drop" on ArmaLite and gain the prestige of presenting the first rifle, Winchester had been caught short when the early, informal Infantry Board range requirements were upped to 500 yards. In attempting to pack the short-necked .224E1 case with more powder, Ralph Clarkson discovered the same high chamber pressures Gene Stoner had recorded in *his* attempt to load a 500-yard capability into the standard .222 Remington case. (Stoner later estimated the .224E1 round, in a hot chamber, consistently gave pressures in the 60,000 psi range: this was about 2,000 psi over what they were then using as a *proof* load.) The Winchester entry was accordingly withdrawn for ballistic improvement, and was not ready to compete against the AR-15 in the Infantry Board trials of March 1958.

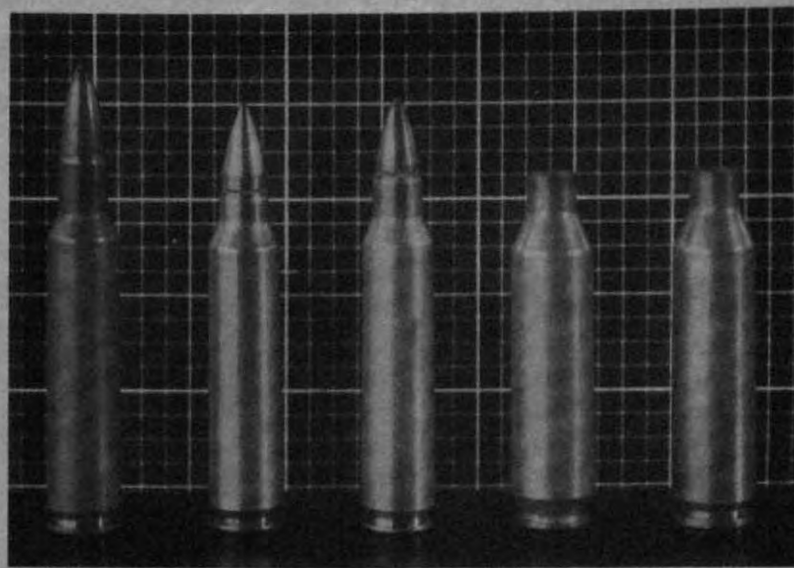
Winchester's chamber pressure problems led them to the same decision Stoner had made: they made the case neck a little longer and used a different powder. Not simply a different lot or grain size of powder, as Stoner had done, but, interestingly,



82. Factory drawing of the Winchester/Western 53-grain, flat-based .224E2 bullet, showing the cannelure moved forward to enable the (longer-necked) .224E2 cartridge to seat and feed.



83. Factory drawing of the maximum cartridge and minimum chamber for the Winchester/Western .224E2.



85. The (actual size) SCHV rounds in contention with Gene Stoner's ".222 Special" (figs. 76 and 141). From left: 1. Earle Harvey's short-lived, unheadstamped ".224 Springfield" round, loaded by Remington and later commercially marketed as the ".222 Remington Magnum"; 2. the Winchester/Western ball-powder-loaded .224E1, unheadstamped; 3. the longer-necked IMR-loaded Winchester .224E2, headstamped WCC 58; and two unheadstamped examples of Winchester's later SCHV experiments: 4. the rare .224E5 (fig. 86); 5. the .224E4. Note the larger case size and rebated rim of the .224E5.

Editor's collection

a completely different *type* of powder; not even their own product. Remington, a DuPont subsidiary, had dimensioned both the commercial .222 Remington and ArmaLite's .222 Special cartridges around the properties of one of DuPont's proprietary Improved Military Rifle (IMR) powders known as IMR4475. In fact, according to later testimony and the events related above, Stoner expressly designed the AR-15 around IMR powder. It is interesting to consider Olin here being "forced" to choose IMR over ball powder in the .224E2, a round with the same chamber profile as the .222 Special, while later advocating the fateful switch to ball powder in the 5.56mm cartridge (chapter 9).

Meanwhile, the very heart of the Winchester Light Weight Military Rifle; the bolt, receiver and magazine; had all been

20 Cal. 224 Winchester E 2 20

53 Gr. Ball Bullet

M. V. 3300 ft./sec - 20" barrel

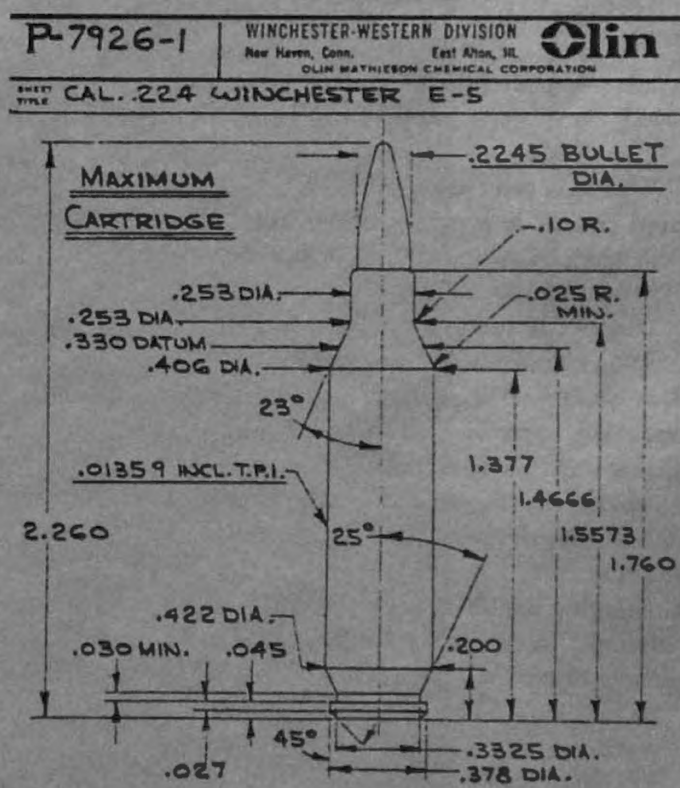
WINCHESTER - WESTERN DIVISION

OLIN MATHIESON CHEMICAL CORPORATION

EAST ALTON, ILL.

84. Twenty-round box label for the Winchester .224E2 cartridge, as supplied for Infantry Board trial in 1958.

Courtesy James Alley



86. A drawing dated April 25, 1963 by Olin engineer D. Whitten, of the "Maximum Cartridge, Winchester .224E5". Independent proof of Frankford Arsenal's warning that the case volume of the .223 Remington (or the .224E2 Winchester) was "insufficient to accommodate the necessary charge" to consistently meet the OSD's ballistic criteria with IMR powder (chapter 8). Interestingly, in 1955 Frankford had recommended the .25 Remington cartridge case as the basis of a successful SCHV round. "About .045" larger" than the .222 Remington family, the .25 Remington is virtually identical in case diameter to the Winchester .224E5 shown here.

built around the original .224"E1" round. Time had flown; the intended Infantry Board comparison of the two rifles had already begun, without the Winchester. Expediency therefore suggested seating the flat-based 53-grain bullets more deeply into the longer-necked E2 cases, so the cartridge would still fit and feed in the existing rifle. The .222 Special would

> *..About this time Winchester managed to get a contract similar to ours on the light rifle program. They demonstrated a rifle firing a .224E1 round..loaded with ball powder and.. a 53 grain flat base bullet. The velocity of the Winchester round was the same as ours, 3,300 fps.*
>
> *After the program was under way I was notified by Winchester that they would have to make some changes in their round. This change was brought about by the fact that the ball powder they used would develop too high breech pressures in a hot chamber. They were forced to switch to an IMR type powder, and needed more case volume.*
>
> *Winchester and ArmaLite agreed on a common cartridge size so that either the Remington loaded [.222 Special] round or theirs would function in the ArmaLite rifles. One problem did exist, however; the Winchester round now called*

chamber in the Winchester rifle, but it was .090" longer overall, and would not feed up through the magazine well. Hence, as Stoner recorded, in order that ArmaLite's results could be compared to later tests with the Winchester rifle, the AR-15 initially had to fire the common but ballistically inferior .224E2 round:

> *the .224E2 was loaded with the bullet deep in the neck of the cartridge. This was done to keep the overall length down to fit their existing gun design...The final results were that the AR-15 would fire either round, but the Winchester could only fire the .224 round in the Army test programs.*
>
> *This made almost all the test results poorer than would have been..[with] the .222 Special round. ArmaLite's tests showed that the better bullet design in the .222 Special had much better penetration at long ranges. Another fact became apparent later on when it was noted that the Winchester rounds would lose a considerable number of primer cups in various adverse tests. In a rain test [of the AR-15] at Aberdeen the Winchester rounds used had 50% of their primers loosened in 600 rounds. This test was repeated with the Remington loaded .222 Special with no cartridge case casualties.*

Modifications to the First AR-15s

Thanks in great part to the experience ArmaLite had gained from the AR-10 program, the March, 1958 Infantry Board field test had identified only a few relatively minor initial "bugs" in the AR-15s. Aside from beefing up the barrel a little, as discussed below, Stoner records all the changes he made to several of the first seventeen rifles, as follows:

1. trigger pull reduced to approximately 7 lbs.
2. trigger return action improved
3. single, conical fiberglass handguard replaced with two-piece removable type, secured with spring-loaded knurled ring
4. rear sight mask increased in size
5. change lever positions changed (originally, SAFE was straight up; dragging rifle by muzzle could rotate lever to AUTO).
6. charging handle changed from AR-10 type to a serrated "triangle" at the rear of the receiver (the old "finger" type, directly above the bolt carrier key, got too hot on sustained fire, and also could not be operated while wearing Arctic gloves)
7. increased clearance in receiver around magazine, for sand, etc.
8. molded rubber buttcap added to fiberglass stock
9. more clearance allowed around buffer
10. receiver contact surfaces (lands) on bolt carrier reduced
11. dust cover cam added
12. feed ramp altered
13. magazine capacity reduced from 25 to 20 rounds
14. barrel 2 oz. heavier; flash suppressor added to muzzle end

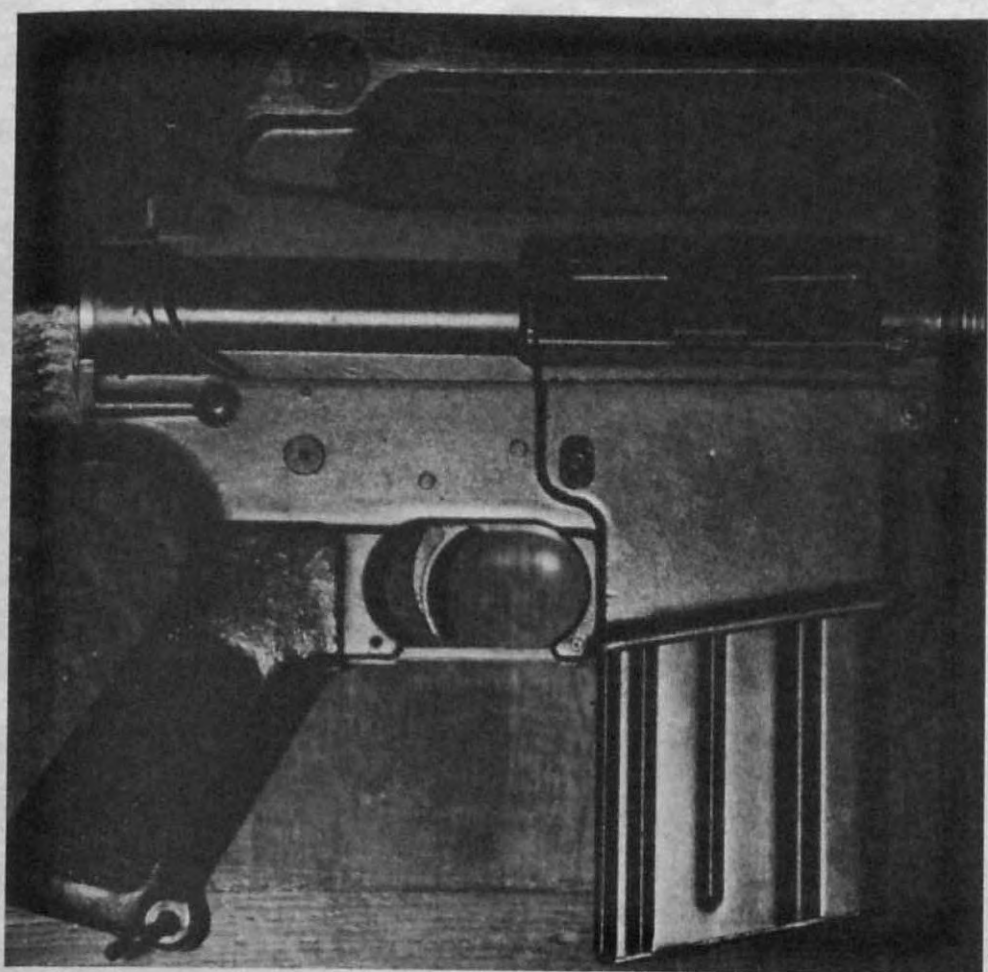
The first AR-15 so modified was tested briefly at Fort Benning and pronounced fit for safe trial by other interested stations. Accordingly, to the growing concern of Dr. Carten, modified AR-15s from this first series of seventeen rifles were soon being put through their paces all around the country.

This concern deepened somewhat when the Infantry Board initially found the AR-15 "superior" to the control rifles in several important categories. In three clean starts through the sand-and-mud simulated combat trials at Kyle range, for example, whose ruggedness Stoner himself has already described, the AR-15s had fired 3,578 semi-auto shots with an overall malfunction rate of 6.1 per 1,000 rounds. The hand-picked Springfield Armory T44E4s had fired only 2,337 rounds, but turned in an overall malfunction rate of 16/1,000; nearly *three times* that of the developmental AR-15s.

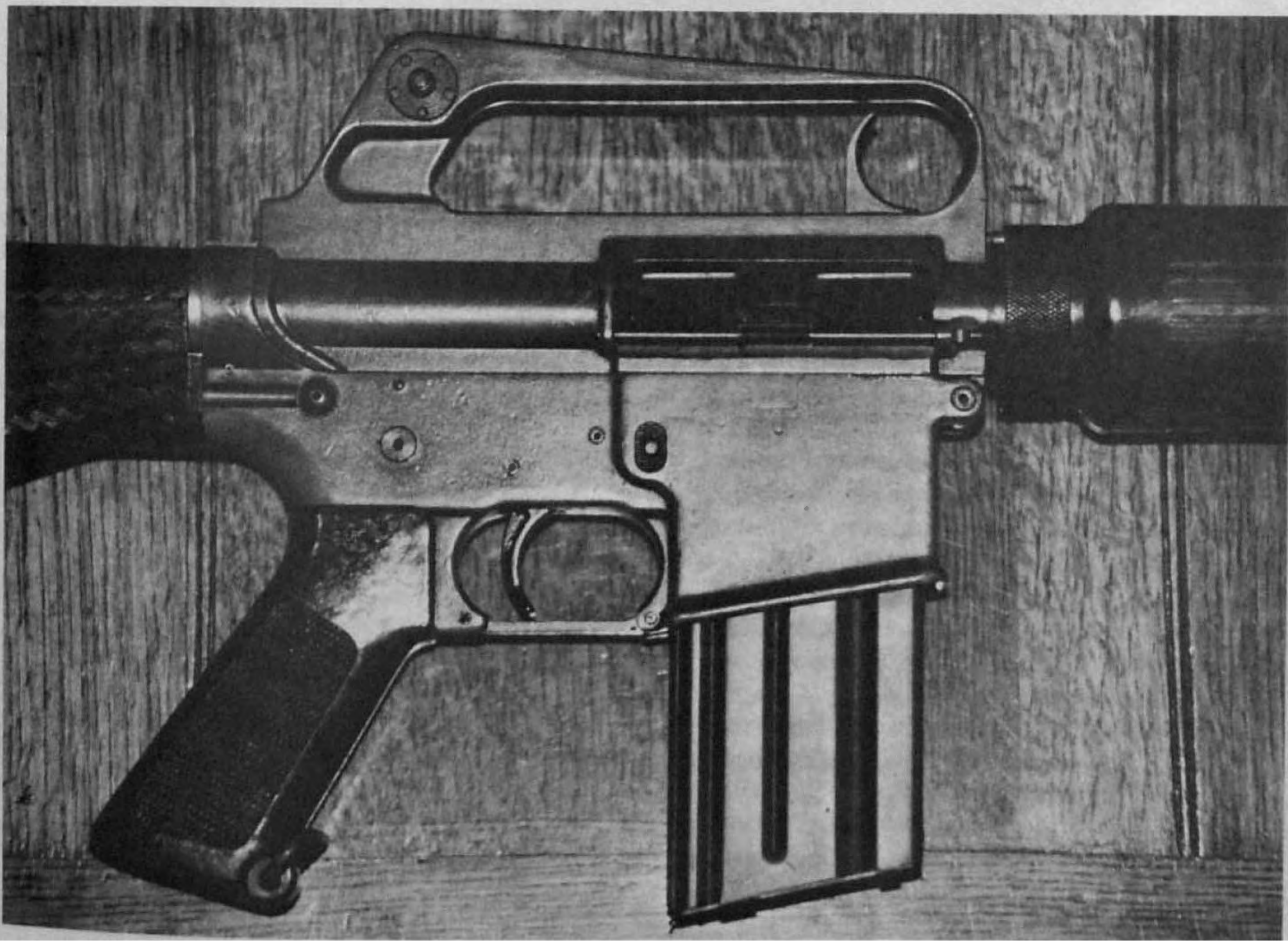
87. Left side views of the earliest ArmaLite AR-15s in existence, serial nos. 000002 (above) and 000003 (below). (By all reports, serial no. 000001 was destroyed in testing).

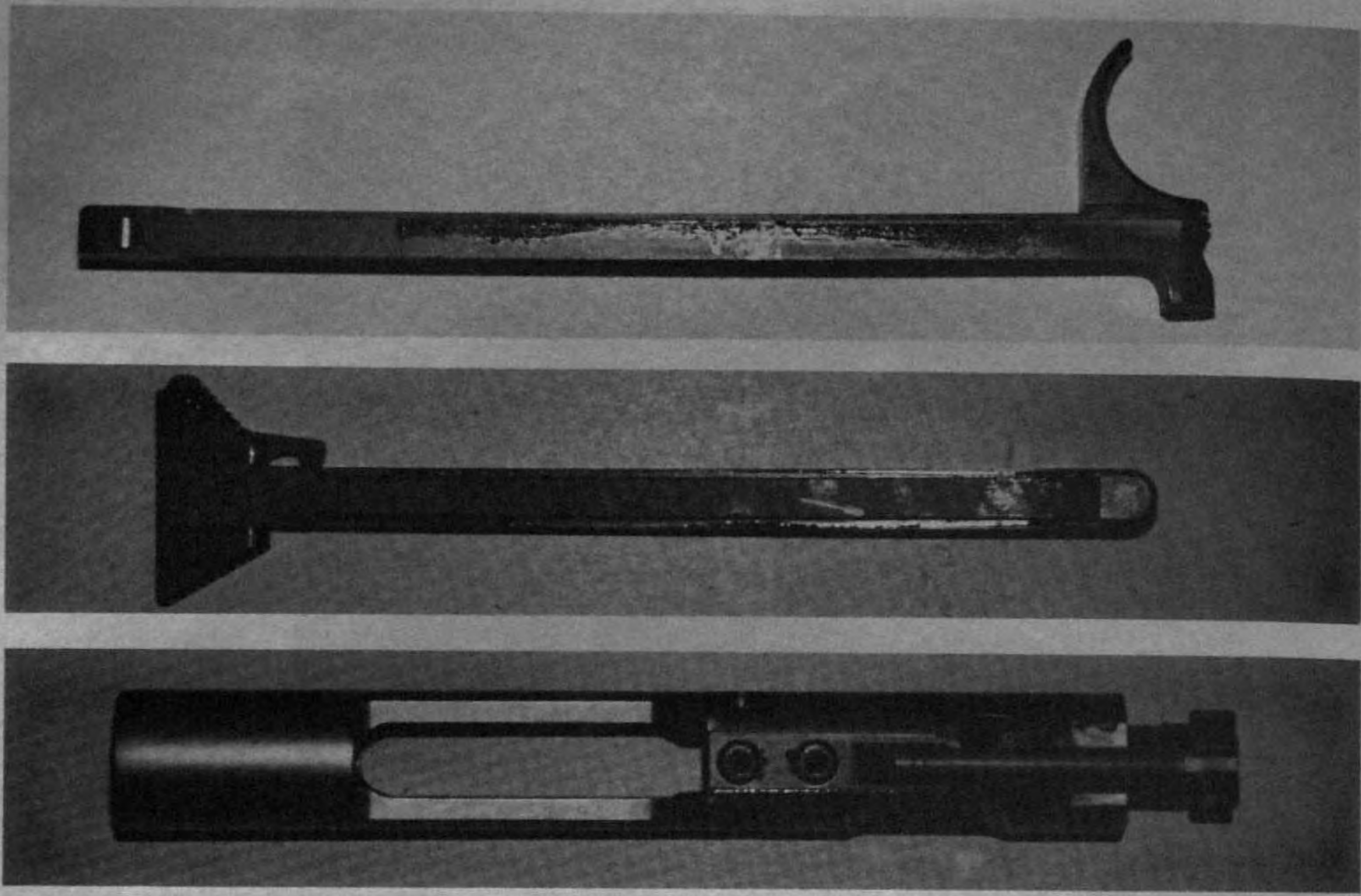
Courtesy Sidem International. Photo credit: Vic Tuff

88. A closeup view of the receivers, left side, of the earliest ArmaLite AR-15s. Although serially numbered earlier than no. 000012 (fig. 75), various modifications, such as those recommended after the initial Infantry Board trial in March, 1958 have been made to both weapons. Rifle no. 000002 (above) has an experimental grooved slip ring and hence a two-piece, demountable forend (mod. no. 3); the new serrated "triangle" charging handle (mod. no. 6); and altered "type 2" selector markings (SAFE now forward; mod. no. 5). Rifle no. 000003 (below) has a knurled slip ring and type 2 selector markings, but retains its original AR-10-style charging handle.



89. Closeup of the two receivers, right side view. No. 000002 (above) with modified charging handle. Both weapons feature woven fiberglass buttstocks, pistol-grip sling swivel, and the original 25-round magazine. Faint markings ("L" and counterclockwise arrow) appear on the windage adjustment knob.



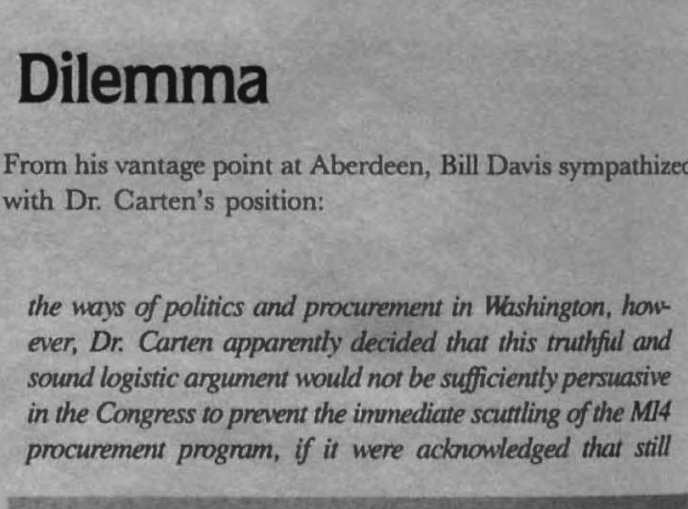


90. The two charging handles (no. 000003, above; note detent at rear) and the original chromed bolt assembly.

Dr. Carten's Dilemma

The nine-pound T44E4 "Light Rifle" had by this time officially been adopted as US Rifle, M14, although mass-produced rifles were not due to come on stream until 1960. From his vantage point at Aberdeen, Bill Davis sympathized with Dr. Carten's position:

> *..I was not privy to specific information on numbers of rifles in inventory at that time, but it was said that the number was insufficient to meet possible mobilization requirements. If that was true, then it was indeed necessary to procure additional rifles very soon. No experienced planner would have concluded that the production of AR-15 rifles could begin forthwith, notwithstanding the opinions to the contrary that were expressed years later, by people who had no experience in such matters. Plans had been laid for the production of the M14, which was at least a moderate improvement over the M1 rifle, and it used the NATO-standard 7.62mm ammunition, an advantage not to be considered lightly. To meet immediate requirements, it therefore seemed necessary to press on with production of the M14, since the only practicable alternative was to produce additional quantities of obsolete caliber .30 M1 rifles on the existing tooling.*
>
> *Of the practicable choices, the plan to push forward with production of the M14 was by far the better. Being wise in the ways of politics and procurement in Washington, however, Dr. Carten apparently decided that this truthful and sound logistic argument would not be sufficiently persuasive in the Congress to prevent the immediate scuttling of the M14 procurement program, if it were acknowledged that still*



91. Handguards, serial no. 000003. The heat reflector is made of metal foil epoxied to the inside of the handguard halves.

another rifle was already on the horizon. There were then, even as there are now, some members of the Congress eagerly awaiting any pretext to justify reductions in military spending, quite irrespective of the possible consequences. Dr. Carten's fears concerning the plan to produce the needed rifles were probably not unfounded..

Raising the Stakes - The First-Ever AR-15 Engineering Tests

In conjunction with the Infantry Board's "user" trials, Ordnance mission responsibility included engineering, or "technical" trials of the fledgling AR-15s. In first presenting the AR-10 to the Ordnance establishment, Fairchild had found the basic reaction to their radical new alloy-and-plastic, straight-stocked rifle to be one of distrust and skepticism. Indeed, as recorded above, the Springfield Armory trial had featured a near-disastrous barrel failure and had concluded that the AR-10 was "not satisfactory as a military service rifle".

Embracing the SCHV concepts in the .222 Special AR-15 had made an "issue" out of caliber, additionally earning ArmaLite the implacable disfavor of the entire camp of "full-power" advocates. As if this wasn't enough, Fairchild found that by engaging the services of the outspoken Mel Johnson they had unwittingly compounded their problems, for Johnson's battle to unseat the M1 with his own rifle, while twenty years old by this time, had waxed very bitter indeed. The Army remembered. So did Johnson, who, as noted, had lost no time in "freely expressing" his suspicions that the ArmaLite rifles were being given every opportunity to fail.

In any case, Bill Davis describes some interesting preliminary footwork on the part of both the OCO and Fairchild:

..I do recall that there was some maneuvering behind the scenes about where those [engineering] tests were to be conducted. Dr. Carten's office had reportedly preferred that they be done at Springfield Armory...[Fairchild's] (retired) General Devers..had reportedly prevailed upon some of his acquaintances in the Pentagon to direct that the tests be conducted at Aberdeen instead..on the grounds of ArmaLite's perception that Aberdeen was more to be trusted in the matter of conducting an impartial and objective evaluation. Dr. Carten's preference for Springfield Armory was thus overruled..

The Curiously Missing Results of the First Aberdeen AR-15 Trial

The relations between ArmaLite and the Office Chief of Ordnance, never really amicable, were strained even further by the AR-15's decisive success in the March 1958 Infantry Board field trial. This victory was short-lived, however, for despite General Devers' "string-pulling", Dr. Carten adamantly protected the M14 procurement program.

Bill Davis recalls having first seen an AR-15 when specimens from the first 17 rifles were sent to Aberdeen for the mentioned 1958 engineering trials. A description of these tests constituted the elusive Fifty-Seventh Report on Ordnance Project TS2-2015 of February 1959, entitled *A Test of Rifle, Caliber .22, AR-15; Rifle, Lightweight Military, Caliber .224 [Winchester]; and Pertinent Ammunition*, by Laurence F. Moore.

Excerpts from Mr. Moore's reports have appeared numerous times in previous Collector Grade books. A top-ranking competitive shooter, Larry Moore was for many years the main civilian test engineer with the Infantry and Aircraft Weapons Division's Development and Proof Services (D&PS) at Aberdeen. He performed the prescribed engineering and accuracy tests with meticulous care on a vast number of US and foreign small arms.

A strong characteristic of most of his reports was the outspoken, not to say fearless, evaluation of a weapon as one *with which America might have to go to war.* In this he felt, and many would agree, that no trial he could devise would approach the reality of combat: better a fault or inherent weakness should be discovered sooner rather than later. As can be imagined, however, when these critical recommendations and conclusions extended to the basic *design* as well as the performance of Ordnance-sponsored weapons, which they very often did, Moore's uncompromising attitude was not so well appreciated in the Pentagon offices of the Ordnance Corps.

With this in mind it is interesting to note that the published version of Larry Moore's Aberdeen report on the AR-15 and Winchester .224, as well as two further trials discussed in chapter 4, contain none of the usual recommendations or conclusions. Bill Davis explains:

..when the test directive was received in the Small Arms Branch at Aberdeen, for which I was then responsible, I assigned the test to Larry Moore, an engineer of outstanding competence and unquestioned integrity, and I requested that I personally be selected as one of the riflemen who would fire in certain of the tests. I did fire in some of the tests, and was quite favorably impressed by the performance of the AR-15s.

I was particularly interested in the AR-15, because it embodied almost precisely the characteristics that G. A. Gustafson and I had suggested to the Office Chief of Ordnance [1955]..

..the testing done..in 1958 turned out very well for the AR-15, especially considering its early stage of development. The results were given in the D&PS report [but] the conclusions and recommendations, which were normally included in our engineering-test reports, were conspicuously absent... They were in fact given directly to Dr. Carten's office, but were omitted from the published report by his direction. Our conclusion was, in substance, that the AR-15 was an exceptionally promising design, and we found no significant faults that could not be corrected in the normal course of development...Our recommendation was that development of the AR-15 proceed, under Army sponsorship.

The Rain-in-the-Bore Issue

During a "supplemental" rain test at Aberdeen, Larry Moore had reported that the original fluted barrel of an AR-15 had split when fired with droplets of water in the bore. Dr. Carten seized upon this as the AR-15's "Achilles' heel", despite the fact that such barrel failures were not necessarily peculiar to the AR-15 and were in any event correctable, given a normal course of engineering development.

In the official record of a developmental process such as we are discussing, as much damage can be done by not saying something good as by saying something bad. The story of the AR-15 and the later M16 certainly has its share of such errors of omission. As regards the AR-15's barrel splitting due to water droplets in the bore, one can choose among several official accounts which differ chiefly in what they left unsaid.

Gene Stoner's own historical notes from this period are perhaps closest to revealing the truth behind the bluster. As noted, after the AR-15's barrel failure in the initial Aberdeen rain test he had made up a new unfluted barrel, slightly heavier than the original. Aberdeen's tongue-in-cheek conclusion to him after the supplemental rain test was that "a modified barrel (2 oz. more) demonstrated a level of safety comparable to standard rifles". In other words, *any* rifle barrel light enough for standard military use would often burst if fired with enough "water droplets" in the bore.

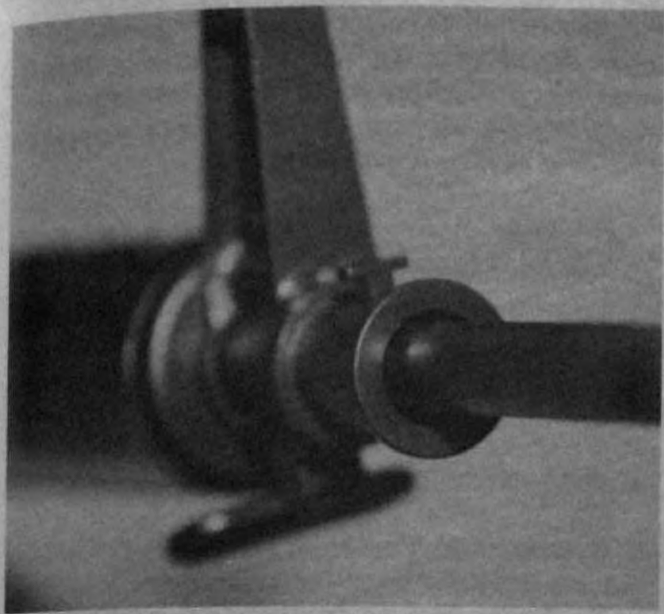
The Infantry Board's Final SCHV Report

The Infantry Board released its final report after a separate trial of the Winchester .224E2 in July and a supplemental trial of the AR-15 in August. During this time the Board's enthusiastic recommendation that the AR-15 be considered as a potential replacement for the M14 had been considerably watered down:

Headquarters
United States Continental Army Command
Fort Monroe, Virginia
September 19, 1958

Report of Project NR 2787, Evaluation of Small Caliber High Velocity (SCHV) Rifles

[Previous] evaluations were conducted to determine the potential of a high velocity small caliber rifle to replace the M14 and M15 rifles. Control for the evaluation consisted of the M14 rifle using 7.62mm, M59 ball ammunition. The AR-15 and Winchester rifles were tested with the Winchester .224 round. Remington caliber .222 [Special] was also fired from the AR-15 in penetration tests.



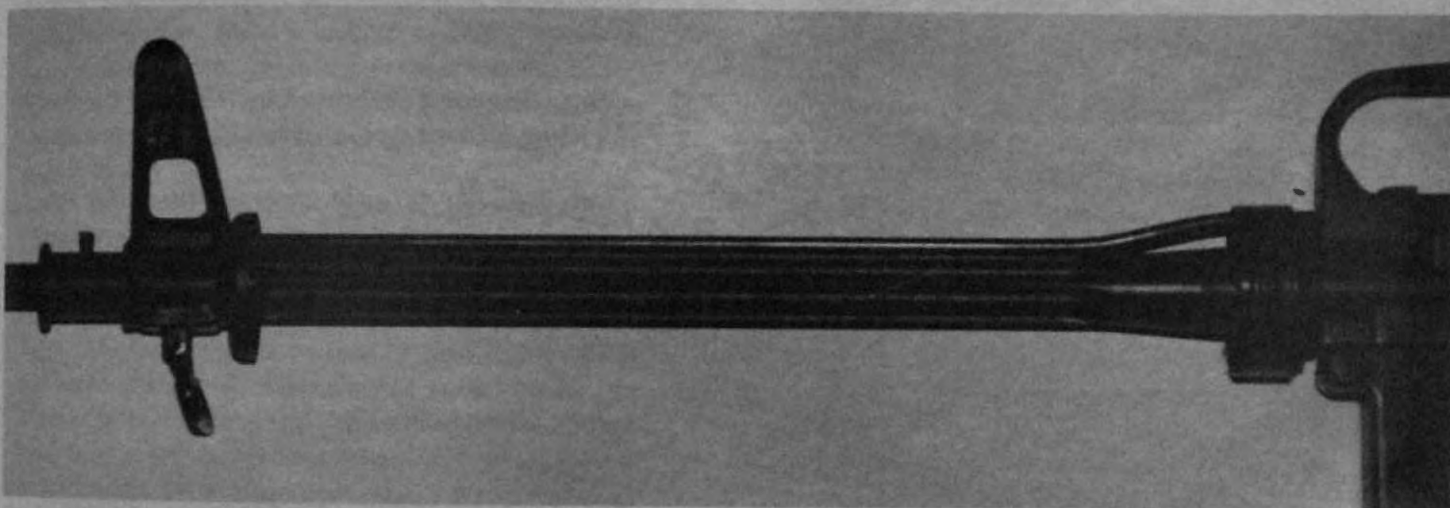
92. Bipod mount, affixed to front sight block and not barrel. Note the stud on top of the ring, intended as a bipod stop.

Both test weapons were superior to the control weapon in lightness of weight and ease of handling. The significance of the weight saving in the rifle/ammunition combination is such that a soldier with a battle load of 22.39 pounds, including his weapon and magazines, carries three times as much ammunition with either SCHV weapon as with the M14 (actually about 650 rounds versus 220 rounds).

The AR-15 was superior to the control weapon and the Winchester rifle in ease of assembly and disassembly and reliability under simulated combat conditions.

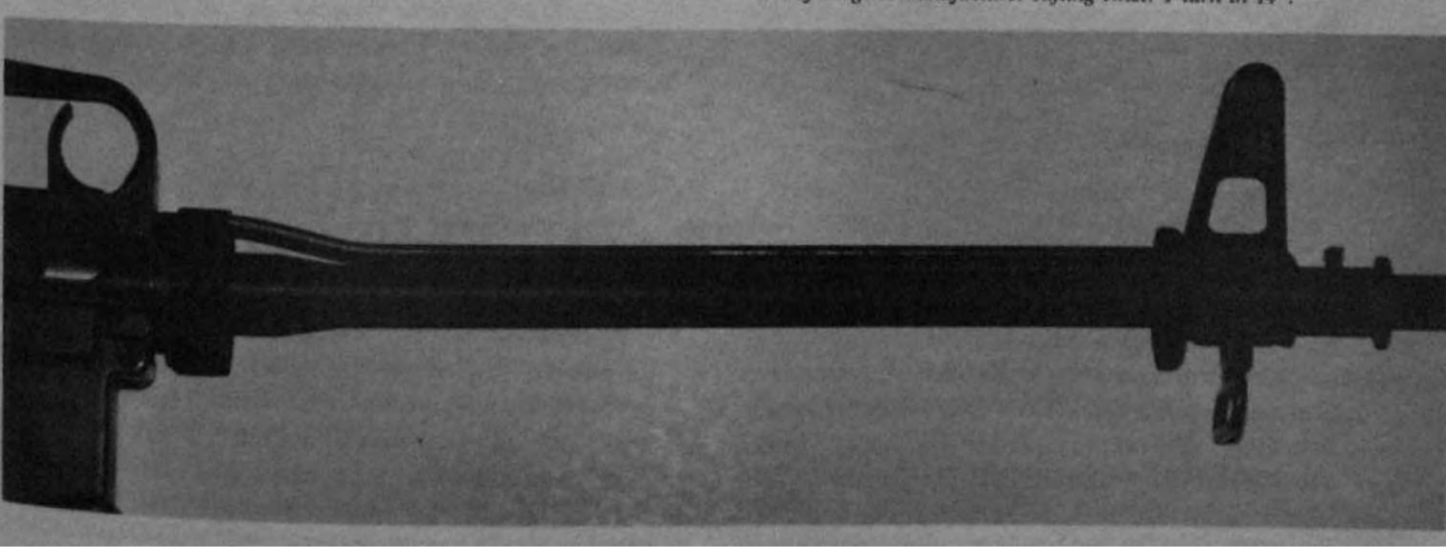
Both test rifle/ammunition combinations were inferior to the control rifle..with regard to penetration and position-disclosing effects.

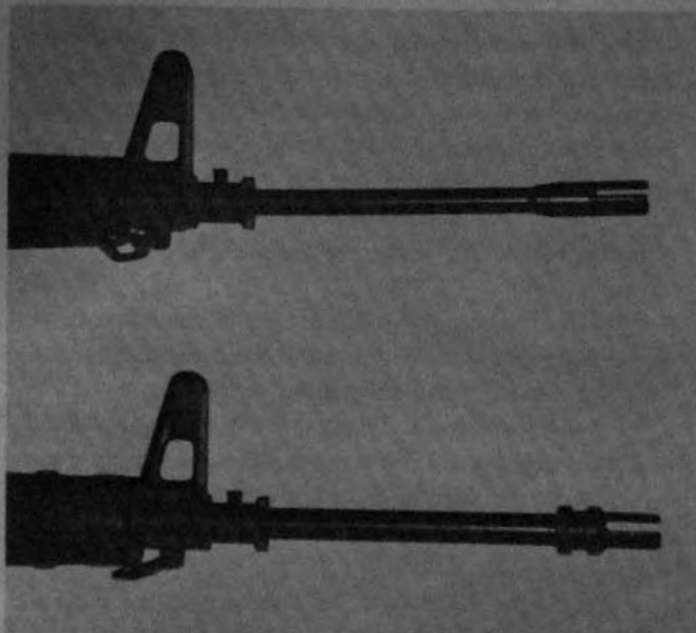
In other tests the control and test weapons were about comparable, except that the sights on the test weapons are indicated to be inferior to those of the M14 rifle.



93. Closeup view of both barrels.
Above: serial no. 000002, caliber .222 Remington Special (.223). Fluted barrel with no caliber or proof markings. Rifling twist: 1 turn in 12".

Below: serial no. 000003, caliber .222 Remington. Plain barrel, marked with factory "U" and ".222"" and the Belgian C-in-circle surmounted-by-flaming bomb (also on chromed bolt carrier), denoting arms proofed in Belgium but not of Belgian manufacture. Rifling twist: 1 turn in 14".





94. Muzzle ends of the two early barrels. Serial no. 000002 (above) with experimental flash hider; no. 000003 (below) with improved version flash hider/grenade launcher.

The AR-15 SCHV rifle failed rain tests at Aberdeen Proving Ground and at the US Army Infantry Board...The rifle was badly damaged during supplemental test firing because drops of water from artificial rain collected in the bore around and near the cartridge. During the tests at Aberdeen..it was revealed that the barrel ruptured during firing when a few drops of water collected in the bore near the muzzle. The same results were experienced..in testing the Winchester rifle. Supplemental rain test of the Winchester by the US Army Infantry Board was deemed unnecessary in view of the results determined by Aberdeen...

..Engineering tests conducted at Aberdeen..indicate that the rain-in-the-bore deficiency may exist in .25 caliber or larger weapons. In addition, tests conducted at Aberdeen.. indicate that it is not feasible to correct the deficiency through partially extracting the cartridge and draining the weapon.

The ArmaLite and Winchester rifles have demonstrated sufficient potential to justify continued development but are not acceptable for Army use at this time.

Although current testing has pointed up the ArmaLite AR-15 more favorably than the Winchester rifle, both developers should be given full opportunity to correct the deficiencies noted in testing and to provide completely modified weapons for retest as early as possible.

The rain-in-the-bore and "ammunition disintegration/ penetration" deficiencies are major deficiencies.

The deficiency of rain-in-the-bore should be corrected mechanically, and if possible without resort to a muzzle protector not a part of the weapon.

This headquarters recommends that:

Pertinent results of evaluation and testing by the US Army Infantry Board and Aberdeen Proving Ground be released to the developers of the ArmaLite AR-15 and Winchester SCHV rifles.

Both developers be encouraged to modify their weapon to correct all deficiencies enumerated..and..as a result of Ordnance testing.

Engineering tests on the modified AR-15 and Winchester rifles be conducted concurrently with service testing.

..Quantities of [16 each] AR-15 and Winchester rifles.. modified to correct all deficiencies..be provided at the earliest possible date to USCONARC for further evaluation and service test by the US Army Infantry Board and the US Army Arctic Test Board.

For the Commander

[signed]

William A. Keil
Major, AGC
Asst Adjutant General

The Great OCO 6.35mm "Shell Game"

Meanwhile, from the Office Chief of Ordnance, a gigantic red herring was drawn across the path of the SCHV proponents: Dr. Carten announced that the AR-15 should be totally rebuilt around a new series of .25 caliber (6.35mm) cartridges, "intermediate" between the .223 (5.56mm) and .30 (7.62mm). The increase in bore size to .258-inch, he said, would be sufficient to allow water to drain away with less of the "capillary action" inherent in the smaller-diameter .22-inch bore.

As discussed in *The SPIW*, Simplex (single bullet) and Duplex (double-bulleted) versions of both short- and long-cased .258 caliber (6.35mm) cartridges (fig. 68 nos. 5 and 6) were accordingly designed and produced by Frankford Arsenal and Olin's Winchester/Western Division, and faithfully fired from modified commercial rifles at several Ordnance test stations in conjunction with ongoing trials of other Project SALVO developmental bullets and flechettes.

It appears that the .258 program was indeed conceived and intended solely to disrupt and thus confound the SCHV camp. With such a flimsy base in reality it is perhaps not surprising that the ploy did not work, although it diverted energy and dollars away from better uses. The .258 cartridge project lasted about two years before finally revealing itself to be an expensive evolutionary dead end. Contracts were promised to ArmaLite for the development of .258 caliber rifles, but never materialized.

Dirty Tricks in the Arctic?

As if to prove the vociferous Mel Johnson right in his constant preoccupation with foul play on the part of the Army, Gene Stoner soon learned a further lesson in how the Ordnance Corps took care of its own. He relates the events surrounding the first Arctic trial of three ArmaLite AR-15s as follows:

I was informed that I would be contacted prior to the Arctic tests and the same procedure [Stoner allowed to attend to assist with troop familiarization and weapon repair, as had been the case at Fort Benning] would be used there. This was considered to be necessary because no one at the Arctic Test Board was familiar with the AR-15..

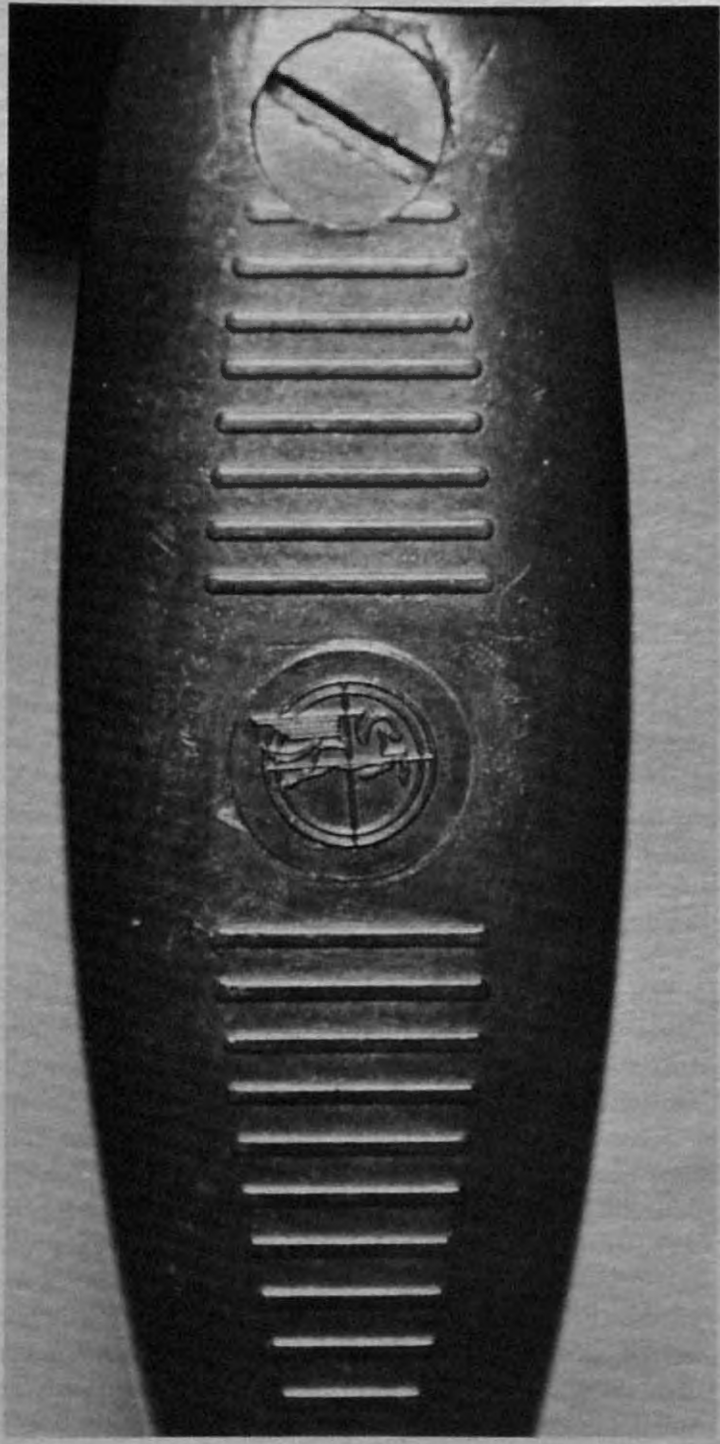
In December [1958] I was contacted at ArmaLite that they were in need of some spare parts at the Arctic Test Board, Fort Greely, Alaska. This was the first indication that I had received of the test having started, and I immediately proceeded to Fort Greely.

Upon arrival I examined the weapons and proceeded to repair them. My examination showed that the front sights had been removed from a couple of the weapons and were loose. (The front sights are retained by taper pins, and there was never any need for their removal.) One rifle had the pins driven in from the wrong side and of course was loose, and the other rifle had ground-down pieces of welding rod substituted for the missing taper pins. I also found some other substituted parts that definitely could have caused malfunctions.

I was informed that the weapons were used in the tests in the condition that I first saw them. I was also told that no one familiar with the weapons had given any instruction on care, firing, etc.

I was given the opportunity to fire one weapon while dressed in full Arctic clothing. This weapon had been outside and subjected to low temperature for several days. I fired 400 rounds and had no malfunctions of any kind. I was impressed by the amount of effort required to handle equipment while in Arctic dress. I was under the impression that the tests were not concluded and that the problems caused by the home-made parts would be mentioned and rectified.

At this time I was contacted to proceed to a meeting at CONARC [headquarters], Fort Monroe, Virginia. Upon arrival..I was informed that this meeting was to be conducted by [CONARC's Deputy Commanding] General [Herbert B.] Powell to determine the future policy of shoulder fired weapons. At this meeting I was asked to give a presentation on the AR-15 program. During this presentation, General



95. Brown molded rubber buttplate (mod. no. 8), the same on both weapons. No drainage hole in screw.

Powell asked about the Arctic tests. I told him we had some minor problems, but that they were taken care of.

..months later I found out that the Arctic test report was read to the Powell Board and [testing] was in fact concluded when I was at Fort Greely. If I had known this, I surely would have informed General Powell when I had the opportunity. The accuracy problems could have been caused by the loose sights, and the weapon would have performed much better with the right parts.

Some Background on the Powell Board

The appointment of the Powell Board had been a last gesture by retiring CONARC Commanding General Wyman, the man who had initiated the request for the development of the AR-15 in the first place. Convinced of the AR-15's merits, he had watched, alarmed, as the OCO relentlessly harped away at the seriousness of the water-in-the-bore issue (and, by adroit inference, its uniqueness to rifles of .22 caliber). As CONARC's Deputy Commanding General, Herbert B. Powell must have concurred in the approval of the Infantry Board's initial recommendation that the "AR-15 rifle be considered as a potential replacement of the M14 and M15 rifles". He had since watched as, in a very few months, not-so-subtle pressures had watered down the Board's statements to the point where both the ArmaLite and Winchester SCHV rifles were deemed "not acceptable for Army use at this time". In any event, the Powell Board's initial recommendation was for the purchase of 750 AR-15s for extended trial.

The Caliber .224 Springfield Infantry Rifle

Meanwhile, as if to prove that Dr. Carten's fears were indeed well founded, yet a third SCHV rifle and cartridge had been produced, right under his nose as it were, at Springfield Armory.

The advent of the commercial .222 Remington cartridge in 1950 had been of particular gratification to Earle Harvey, the designer of the luckless T25/T47 series of rifles, and his colleagues at Springfield Armory. An avid shooter and bench rest enthusiast, Harvey had noted CONARC's burgeoning interest in the SCHV idea and felt, unofficially, that Springfield's design group should have a go at it as well.

Harvey had begun the development of the caliber .30 T65 "lightweight" cartridge, in 1944, by cutting a second seating cannelure in a standard M2 ball bullet and loading it into a commercial .300 Savage case, to an overall length of 2.8". Now, a dozen years later, examination of the "too little" of the Gustafson .22 Carbine and the "too much" of the ".22 NATO" T48 led Harvey, as had Gene Stoner, to choose the commercial .222 Remington round as an admirable starting point for an SCHV cartridge with a 500-yard capability. In Harvey's own words, "From information on cartridge case design and propellant combustion, I decided to retain the .222 case diameter at the front of the case body; the shoulder angle of the .222; to increase the propellant charge; and to increase the bullet weight to 55 grains."

With muzzle velocity and chamber pressure limits tentatively set, case drawings were produced for the new cartridge, and an order given to Remington in 1957 to fabricate an initial

REMINGTON ARMS COMPANY, INC.

MANUFACTURERS OF
SPORTING FIREARMS AMMUNITION
TRAPS TARGETS
POWER TOOLS
BRIDGEPORT, CONNECTICUT 06602

October 31, 1969

Dr. Edward C. Ezell
Assistant Professor
North Carolina State University
Department of Social Studies
Raleigh, North Carolina 27607

Dear Dr. Ezell:

Your recent letter to our Mr. S. M. Alvis has been referred to us.

From our records it appears that we first made a cartridge for Springfield Armory early in 1957 with no headstamp but with dimensions equivalent to our present 222 Remington Magnum.

As to your second question concerning the 223 Remington (5.56mm), in the early part of 1958 we loaded cartridges for Armalite marked 222 Remington Special. These were loaded with 55 grain 3-piece bullets supplied by Armalite. Subsequently, Remington loaded the same cartridge for Armalite using Remington 55 grain bullets of lead core-gilding metal jacket design.

We hope we have been of service. Thank you for your interest.

Very truly yours,

S. C. Toulson
S. C. Toulson
Research Associate

SCT/bta

96. Remington's Research Associate S. C. Toulson kindly provides some early background on the firm's initial involvement in the SCHV cartridge project.

quantity of 10,000 rounds. As it turned out, only this one unheadstamped lot of ".224 Springfield" cartridges was ever produced. Remington reports that after development of a suitable primer, they loaded 9,500 of the new cases with a 55-grain full metal jacket bullet obtained from Sierra, the same firm making the initial lot of 3-piece, 55-grain .222 Special bullets to Gene Stoner's design. Interestingly, the remaining 500 .224 Springfield cases were loaded with Aberdeen's 68-grain, .224 caliber "homologue" of the .30 M1 ball, and were used in further SCHV lethality test firings by Donald L. Hall at BRL.

97. The short-lived "Caliber .224 Springfield Infantry Rifle" serial no. 1, top and right side views. Designed by A. J. Lizza.
Springfield Armory photo dated December 18, 1958

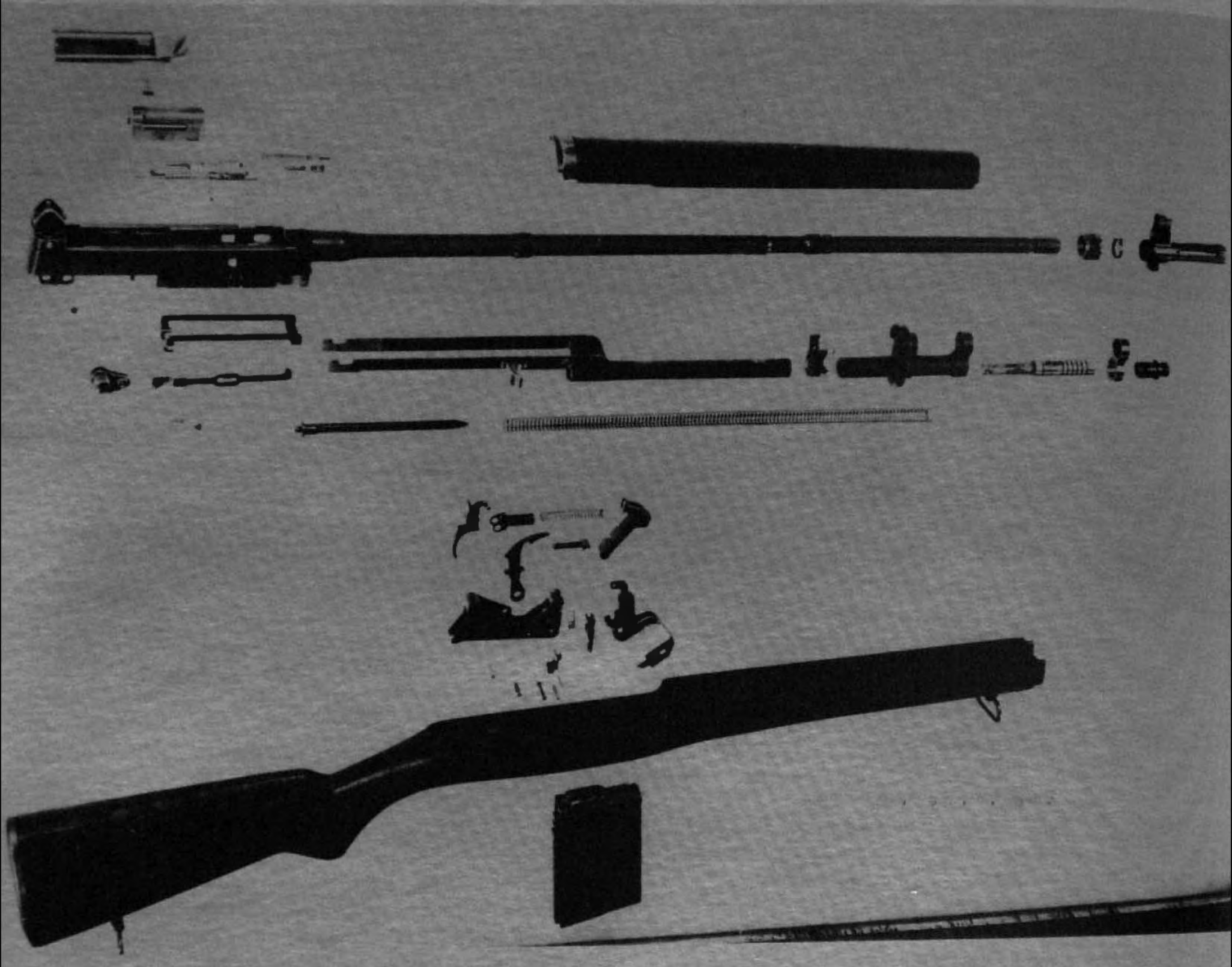
Speaking of evolutionary dead ends, the .224 Springfield rifle itself is interesting, if only in that it sprang from a much higher aspiration than did Dr. Carten's 6.35mm cartridge program. As an unofficial "labor of love" on the part of Albert J. "Tony" Lizza and his associates on the Armory's rifle design team, the .224 Springfield project was a perfect chance to correct all the faults perceived after countless thousands of test-firings of both the T25 and T44 series of rifles. Before the preliminary layout of the .224 rifle was begun, Lizza and his team had decided on a "rotating, front-locking breech bolt in a bolt carrier; assembly and disassembly through the rear half of the top of the receiver; double column box magazine; hammer fire control [a Remington idea, originated in the 1944 T22 rifle program and discussed in ***US Rifle M14***] with selective semi- and full automatic, and a controlled burst capability of four shots per trigger pull; gas cutoff and expansion system of actuation."

Earle Harvey later recalled taking one of the two Springfield .224 rifles ever built to a SALVO meeting at the Pentagon, where the off-the-cuff opinion of most of the assembled representatives of the OCO, BRL and Frankford Arsenal was that the design showed promise and warranted further development.

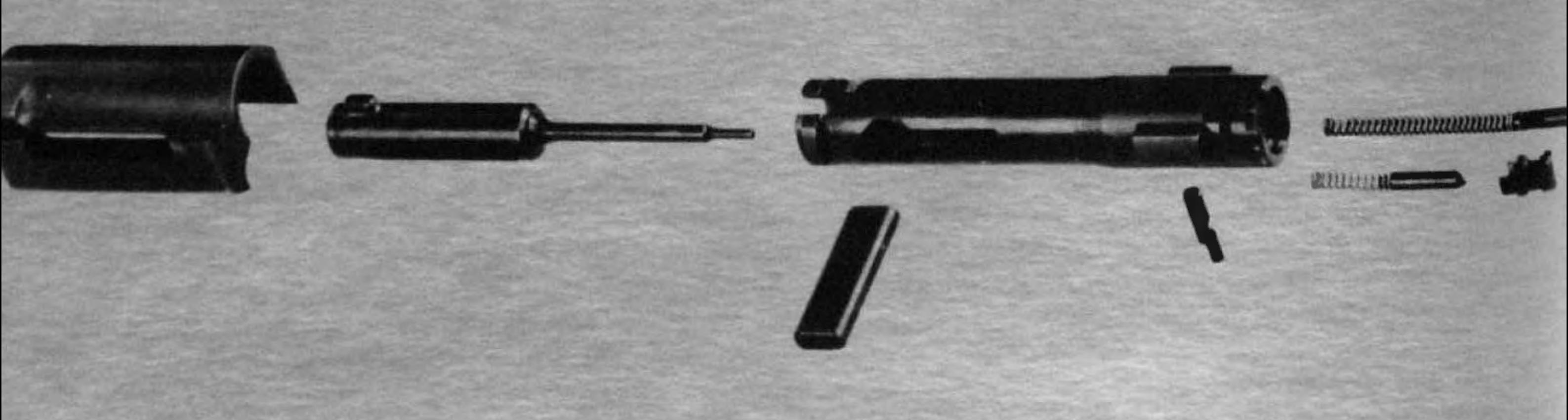
By this time, however, Dr. Carten was already aware of General Wyman's direct and informal "arrangement" with ArmaLite, which the good doctor correctly interpreted as an audacious but unsettlingly effective "end run" around normal Ordnance procurement procedure. He was aghast at the idea of Springfield Armory, an Ordnance Corps agency, entering and thus encouraging the .22 rifle competition. Accordingly, shortly after the initial prototype was completed in mid-1957, the Armory received firm instructions to terminate its .224 rifle project and refrain from any further SCHV development work.

Regarding the actual performance of the .224 Springfield rifle, therefore, not much is known. Harvey was able to confirm that the cartridge as loaded by Remington did in fact have the desired accuracy, lethality and trajectory characteristics. Officially, a brief note appended to a 1960 Army Arctic Test Board report of flechette and 6.35mm Simplex and Duplex firings is all that remains of a "Cal. .22 (Springfield Armory design)". All it says is "data not available".

Of further interest is the fact that the .224 Springfield cartridge did not die out with the rifle. Remington, noting that no further activity was forthcoming from the Armory on the .224 project, approached Harvey and asked whether he thought the Army would have any objection to their loading the round commercially. The Army could hardly protest after having disowned the program, and Harvey's .224 Springfield cartridge was produced and marketed successfully for many years as the ".222 Remington Magnum".



98. The .224 Springfield Infantry Rifle disassembled. From the front, note the M14-type gas cutoff and expansion system, the T25-style operating rod handle with two *bolt carrier contact points (for reduced jarring and vibration), and Mr. Lizza's "stock and action clamp" trigger guard, the subject of US Patent no. 2,912,781, described as "a jaw member pivotally mounted to the trigger housing [and] a trigger guard pivotally mounted to said jaw member for movement between a closed position encircling the trigger and an open winter trigger position".*



99. Bolt group closeup, from the Springfield Armory .224 caliber Infantry Rifle. The long, flat action pin is smoothly actuated from both sides *by the double-ended operating rod (fig. 98).*

The ".222 Special" Becomes the .223 Remington

The proliferation of names for the new .222 offshoots was causing some confusion, particularly between the .222 "Special" and the .222 "Magnum". Therefore, in 1959, Remington announced that henceforth Stoner's ".222 Special" cartridge would be known as the ".223 Remington".

The Powell Board's Reversal - the Final Straw for Fairchild

Certainly, as Stoner related, the somewhat questionable results of the AR-15 Arctic trials may have figured in the Powell Board's deliberations, but not as much as did the sharp OCO denouncement of the Board's initially recommended trials-quantities AR-15 purchase as a direct violation of the hard-won 7.62mm NATO cartridge standardization agreement. Indeed, after perusing, not to say emasculating, the test reports from the Infantry Board and the D&PS, Dr. Carten announced his official conclusion that the AR-15 had not demonstrated sufficient technical merit to support continued consideration for development by the Army.

By February 1959 it was all over. General Maxwell Taylor, Chief of Staff of the Army, upheld the Powell Board's final recommendation that "only the M14 is suitable for Army use". The aforementioned .258 program was solemnly grafted onto Project SALVO. Even Winchester, whose .224E2 Light Weight Military Rifle had been the also-ran in a race that Dr. Carten now fervently hoped had run its course, was consoled with the first-ever, 35,000-rifle civilian M14 production contract. Only Fairchild was left out in the cold completely: as mentioned, the promised contracts for .258 caliber ArmaLite rifles never materialized, and General Taylor firmly vetoed any further Army purchases of .223 caliber AR-15s.

The OCO's Crucial Mistake

Dr. Carten's decision to continue with the M14 procurement program was logistically sound and, indeed, his only viable option: having forced NATO to accept the 7.62mm cartridge, the US could hardly abandon the procurement of a rifle in the NATO standard caliber. Unfortunately, while the "end" of M14 production was attained, at least temporarily, the long-term results of the "means", basically two-fold, were disastrous.

First, as we shall see, when the Secretary of Defense ultimately did show an interest in the AR-15 as a "fully-developed weapon system" in 1963, no significant engineering development work had been done since 1958. The program's subsequent litany of ills begins with this one simple fact. Secondly, even in 1958 it was demonstrably untrue that the AR-15 was devoid of technical merit, and in so stating Dr. Carten had disregarded the conclusions and recommendations of his own experts. This undermined the credibility of the Army's technical services, polarizing and demoralizing the Ordnance technical community. In the process, ironically, Dr. Carten's own authority was weakened, thereby contributing to the demise of the Office Chief of Ordnance itself in 1962.

100. Bobby Macdonald's "old number 4", which he and Gene Stoner took around the world in the spring of 1959. Macdonald later described this Arma-Lite rifle to the Ichord subcommittee as "..the finest, most foolproof weapon I have ever seen in my life". Note the muzzle brake (like no. 000002, fig. 94); the different slip ring arrangement; the type 2 selector lever markings (SAFE forward), and the bipod.

US Army Infantry Board photo dated May 27, 1958, courtesy Lee Rutledge

Chapter Four

A MID-STREAM CHANGE OF HORSES

Fairchild's president Richard Boutelle often argued with the firm's directors on the issue of getting into the gun business *per se*, to no avail. Indeed, back in the summer of 1958 with hopes for AR-10 sales efforts abroad still high and the Army's enthusiasm for the AR-15 as yet undampened by water-in-the-bore, Boutelle had made an impassioned plea to turn the ArmaLite plant in California into a real assembly line, to manufacture the AR-10 and AR-15 themselves. The directors had again refused to finance such a venture.

As noted earlier, the Baltimore-based firm of Cooper-Macdonald Inc. represented the Dutch-made AR-10 in Asia. In fact, Robert W. "Bobby" Macdonald was something of a specialist in Southeast Asia, having lived and worked there for a number of years. In addition to the AR-10, Cooper-Macdonald had since 1948 represented Colt handguns and later Remington rifles, ammunition and shotguns in that part of the world.

Meanwhile, Fairchild's aircraft business was in serious financial difficulty, and the parent firm was increasingly unable to support the significant investment which the AR-15 program required. Mr. Boutelle accordingly gave Cooper-Macdonald the added task of finding, for a fee, someone to take on the job of tooling up and making the AR-15 under license. Bobby Macdonald naturally mentioned the matter to his friend Fred Roff, then sales director and later president of Colt's Patent Fire Arms Manufacturing Co. of Hartford, Connecticut. Roff was interested, but like most of the other traditional New England gunmakers, Colt's was facing ever-heavier financial losses in the dried-up civilian and military markets of the post-Korean war period. An initial, 20-year "letter of understanding" between Colt's and Cooper-Macdonald was put on paper as early as September 22, 1958 regarding "the ArmaLite matter", but it was some months before any actual money could be put together.

As Fairchild's need to salvage some of its ArmaLite investment grew keener, Colt's veered ever closer to actual bankruptcy. The sobering fact was that the manufacturing plant had not been updated in virtually a century. The firm was at length purchased by a New York financier for merely the value of the inventory of firearms already manufactured but still unassembled.

Ironically, the final signing of the arrangement between Colt's new directors and the newly-formed Fairchild Stratos Corporation coincided almost to the day with General Taylor's formal veto of further .22 caliber rifle purchases by the Army. Interestingly, Colt's paid Fairchild Stratos a lump sum of only $75,000 plus a royalty of 4 1/2% on all future production for the rights to the AR-15, while for its good offices in putting the deal together Colt's paid Cooper-Macdonald $250,000 plus a royalty of 1% on future production. Salient portions of the Colt/Cooper-Macdonald arrangement, as later read into the record of the Ichord subcommittee hearings, are as follows:

Cooper-Macdonald was instrumental in bringing about agreements between Fairchild Engine and Airplane Corporation (now known as Fairchild Stratos Corporation) and Fairchild Arms International, Limited pursuant to which agreements, as thereafter modified and supplemented, Colt received the exclusive license to manufacture and sell a lightweight automatic rifle sometimes known as the ArmaLite AR-15 and any variation thereof which incorporates the ArmaLite gas system as defined and elaborated by US Patent no. 2,951,424, issued on September 6, 1960, entitled "Gas-Operated Bolt and Carrier System".

Colt authorized Cooper-Macdonald to promote the use of the foregoing weapon as standard equipment for the US Armed Forces and also to promote [its] sale to foreign governments and other users, both public and private, within and without the continental limits of the United States.

A further broader definition of "ArmaLite military weapons" was later agreed upon, as meaning "the ArmaLite AR-10 and the ArmaLite AR-15 and any variations (e.g., bipod, tripod, heavy barrel, light machine gun, etc.) thereof incorporating the ArmaLite gas system.."

The letter which accompanied Colt's first $5,000 "advance" to Cooper-Macdonald, dated February 19, 1959, ended: "..Receipt of this check will permit you to immediately take off for the Far East to start securing the necessary orders to permit our starting production."

In his testimony before the Ichord subcommittee, Bobby Macdonald later related the events surrounding his introduction to the AR-15 as follows:

..In the process of getting started to sell the AR-10, [Fairchild] developed the AR-15. It seems to me that General Wyman, who was head of CONARC at that time, liked the idea of the small caliber, high velocity rifle, and..the Arma-Lite division of Fairchild scaled down the AR-10 to fit the 5.56, or .223 as that was originally called.

Mr. Boutelle, at that time president of Fairchild, asked me to come up to Hagerstown to see the rifle. I went up there and fell in love with it. So he was about to take off to go to [Fort] Benning with Stoner for the original Army tests of the rifle when I decided that the smart thing to do would be to take both rifles, the bigger caliber and the smaller caliber, and take it around the world, and shoot it under all kinds of conditions.

I was especially interested in a rifle for the Southeast Asian people, one that was light enough for them to carry.

So [in the spring of 1959 Gene Stoner and] I went out there, and we shot [AR-15 serial no. 000004] in the Philippines, Malaya, Indonesia, Thailand, Burma, India, at that time, and then Italy...the more I shot it, the better I liked it. And it seems to be that is the way most everybody in those days felt about the rifle. The fact of the matter was that having both calibers, I ended up by giving away 6,000 rounds of 7.62 in the Philippines, because nobody wanted to shoot [AR-10]. Everybody wanted to shoot the AR-15. So I didn't see any point in carrying [the 7.62mm ammunition] any further.

But to my knowledge, we fired around 8,000 rounds through that one rifle in the course of getting to India, and that means all the Malayans, everybody had a shot with it under all sorts of conditions. And as I recall, we had exactly one malfunction, and that was easily traceable to a lip on the magazine which somebody had bent.

But it was the finest, most foolproof weapon I have ever seen in my life.

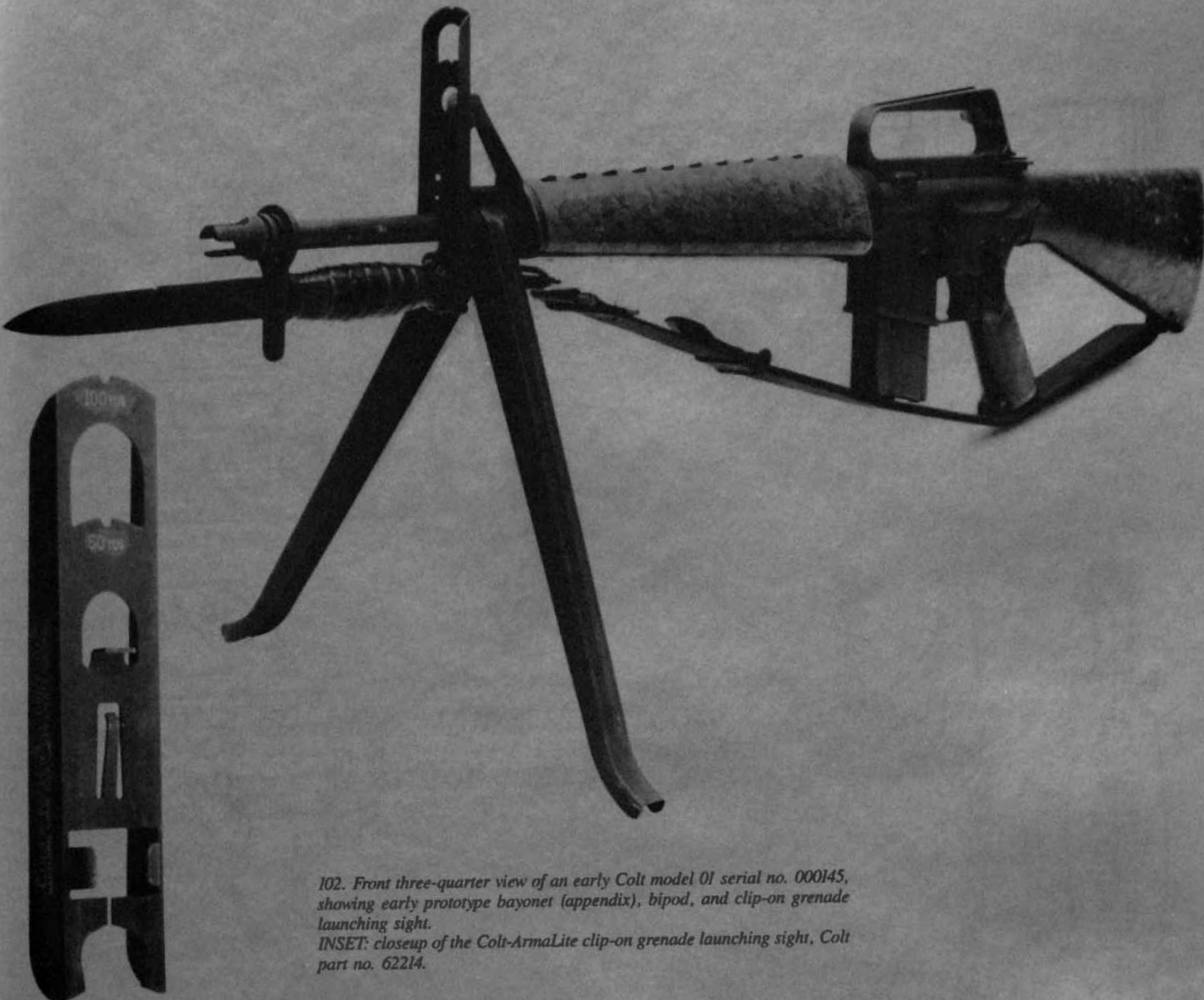
..Well, when I got back to Singapore I cabled Colt who had already spent $100,000 tooling up for the AR-10. I cabled them to stop it and go to full out on the AR-15, because it was obvious that what everybody else had always thought about this [7.62mm] NATO round - it was not as good; it just proved itself with these little people. [Colt's] followed that advice.

Catch-22

101. Left side view of Colt's .223 caliber "ArmaLite AR-15 Model 01" (Colt internal model no. 601, the first of the multivarious "600" series), serial no. 000112. Note the mottled brown "fibrite" furniture and the early steel "waffle" 20-round magazine (appendix).

Bob Miller collection
photo by Roy Arnold

Colt's completed its first-ever run of 300 "model 01" AR-15 rifles, serial nos. 000101 to 000400, in December of 1959. Already Bobby Macdonald was doing his part: in his later Ichord testimony he reported that "..the first [Colt AR-15] rifles that were ever sold were sold to Malaya, 25 rifles, and they were shipped under State Department export license 3404 dated September 30, 1959. The second [23 rifles] went to India under export license 5893, dated December 15, 1959."



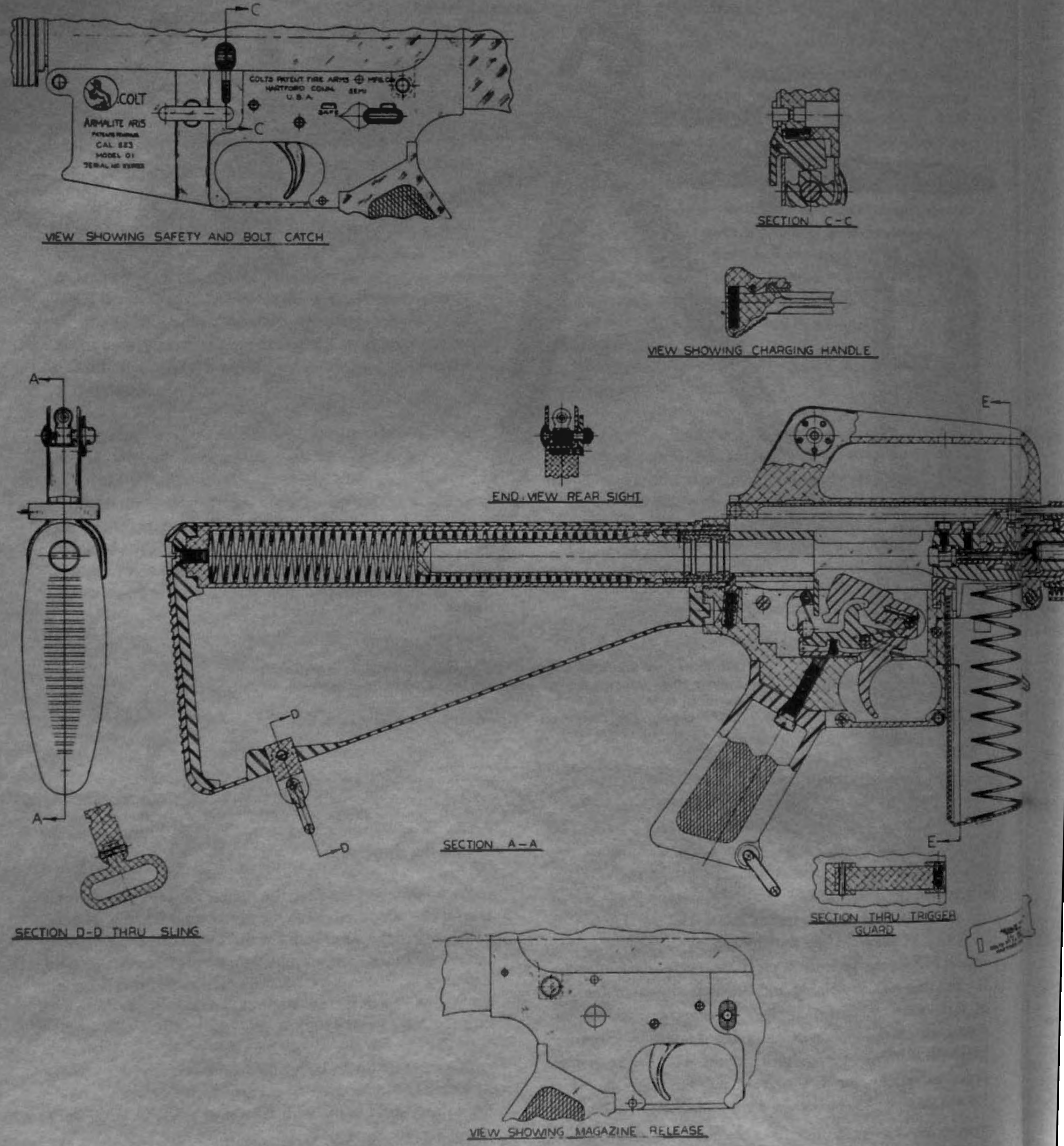
102. Front three-quarter view of an early Colt model 01 serial no. 000145, showing early prototype bayonet (appendix), bipod, and clip-on grenade launching sight.
INSET: closeup of the Colt-ArmaLite clip-on grenade launching sight, Colt part no. 62214.

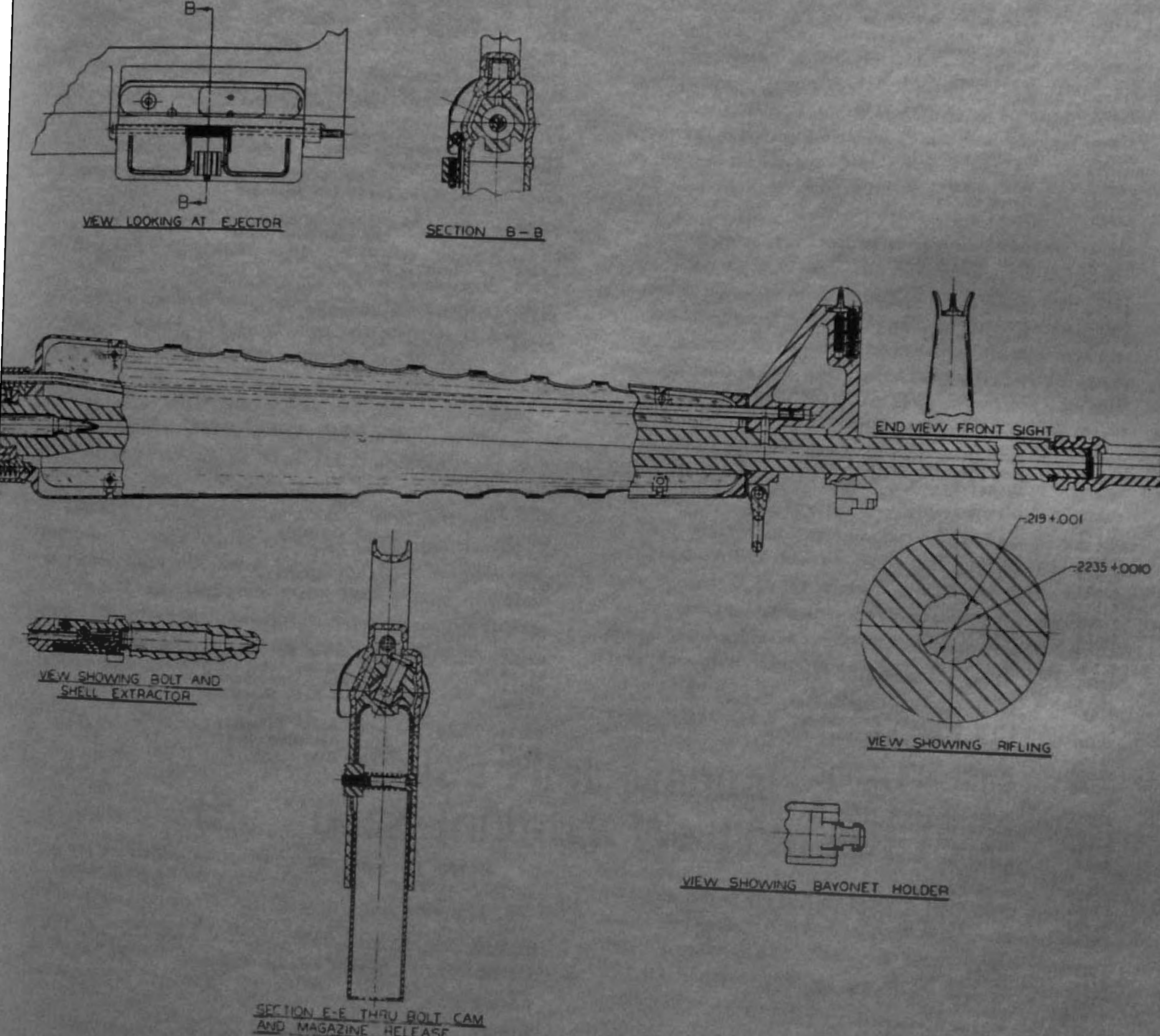
Further relatively small orders, again usually just enough rifles to run a meaningful test with a squad of men, were forthcoming from Australia, Burma, and later the Singapore police. But soon a gigantic paradox became apparent. For many of the small-statured peoples in Southeast Asia the AR-15 was, as Bobby Macdonald had anticipated, particularly suited in almost every way. Indeed, at each and every demonstration the reaction was invariably and unabashedly favorable. Yet at least four would-be foreign purchasers, such as the government of the Philippines, had signed a military assistance pact with the United States government. This meant that, in order to qualify for US mutual aid funding, the arms "purchased" had to be standard US military hardware: M1s, BARs, .45s, Carbines, and so on. The AR-15 was decidedly not on the shopping list.

Back home in Hartford, the double irony of the situation was quickly absorbed. With the future quite literally at stake, Colt's elicited the aid of both Fairchild, who had a direct royalty interest in future AR-15 production, and Cooper-Macdonald, no longer limited to a specified territory as they had been with the AR-10, in a desperate attempt to somehow get the AR-15 into the US military system.

In further testimony before the Ichord subcommittee, Bobby Macdonald summed up the events which followed his return from the "world tour" with ArmaLite's AR-15 serial no. 4:

> *..So I got back here and found that nobody had accomplished much, and I made a deal with both Fairchild and Colt that if they would get out of the way and turn over the whole business to me, I would make a great effort to try to get the rifle tested here and adopted by the US government, not so much to replace the M14, although it was capable of doing so, but to supply our small-statured allies with this type of rifle which has very little recoil, as you know.*


COLT
ARMALITE AR15
CAL .223
MODEL 01
COLTS PATENT FIRE ARMS MFG CO
HARTFORD CONN.
U.S.A.
SAFE
SEMI
VIEW SHOWING SAFETY AND BOLT CATCH
SECTION C-C
VIEW SHOWING CHARGING HANDLE
END VIEW REAR SIGHT
SECTION A-A
SECTION D-D THRU SLING
SECTION THRU TRIGGER GUARD
VIEW SHOWING MAGAZINE RELEASE



103. Skeleton drawings of the AR-15 model 01, from the original Colt manual entitled "Instructions for the Operation of the Colt ArmaLite AR-15 Automatic Rifle, Caliber .223". Courtesy Robert E. Roy

Part No.	Name
61546	Receiver - Upper
62112	Ejection Port Cover Assembly
61658	Ejection Port Cover Pin
90402	Ejection Port Cover Pin Retaining Ring
61518	Ejection Port Cover Spring
61700	Rear Sight
61708	Rear Sight Spring
61702	Rear Sight Windage Screw
61703	Rear Sight Windage Drum
61755	Rear Sight Detent
95101	Rear Sight Windage Drum Pin
61754	Rear Sight Detent Spring
62083	Barrel Assembly
61902	Barrel Nut
61901	Hand Guard Slip Ring
61962	Hand Guard Slip Ring Spring Assembly
90403	Hand Guard Snap Ring
61645	Gas Tube Detail Assembly (Completed and Bent)
95108	Gas Tube Pin
62087	Hand Guard Cap
62068	Front Sight
62086	Front Sight Taper Pins
62096	Hand Guard Assembly LH
62095	Hand Guard Assembly RH
61706	Front Sight Post
61705	Front Sight Detent
61709	Front Sight Detent Spring
61322	Front Swivel
95103	Front Swivel Pin
62070	Flash Suppressor
62126	Flash Suppressor, Lock Washer
62114	Charging Handle Assembly
61826	Bolt Carrier and Key Assembly
61547	Bolt Carrier Key
92201	Socket Head Cap Screw
62116	Bolt Assembly
61538	Bolt
61540	Bolt Ring
61562	Extractor
61568	Extractor Spring
61563	Extractor Pin
61564	Ejector
61569	Ejector (and Safety Detent Spring)
95102	Ejector Pin
61704	Bolt Cam Pin
61548	Firing Pin
61561	Firing Pin Retaining Pin
61573	Lower Receiver * Has serial number. Sold only on return of used receiver.
61574	Lower Receiver Extension
95107	Lower Receiver Extension Pin
61970	Trigger Guard Assembly
95106	Trigger Guard Pivot Pin
61605	Magazine Catch Plate
61606	Magazine Catch Shaft
61759	Magazine Catch Spring
62032	Magazine Catch Button
61599	Bolt Catch
61699	Bolt Catch Plunger
61691	Bolt Catch Spring
95105	Bolt Catch Pin
6195[illegible]	Trigger
61657	Trigger Spring
61654	Trigger Pin (and Hammer Pin)
61918	Disconnect
61925	Spring Disconnect
62117	Hammer Assembly
61654	Hammer Pin (and Trigger) See Trigger Pin
61697	Hammer Spring
61622	Automatic Sear Assembly
61615	Automatic Sear Pin
61582	Buffer Retainer
61694	Buffer Retainer Spring

Part No.	Name
61655	Takedown Pin
61698	Takedown Pin Detent
61692	Takedown Pin Detent Spring
61935	Stock Assembly Molded (No Swivel)
62132	Stock Assembly Molded (With Swivel)
92601	Butt Cap Screw
62119	Action Spring Guide Assembly
65180	Action Spring Guide
61578	Buffer Ring - Outer
61579	Buffer Ring - Inner
61577	Buffer End Rind
61576	Buffer Cap
95101	Buffer Pin
61581	Action Spring
61959	Safety
61785	Safety Detent
61569	Safety Detent Spring (and Ejector) See Ejector Spring
62120	Pistol Grip Assembly
92701	Pistol Grip Screw
90001	Lockwasher
95601	Receiver Pivot Pin Assembly
62139	Magazine Assembly, Stainless Steel (20 rounds of .223)
94004	Cleaning Rod Assembly
91206	Cleaning Brush
62135	Sling Pistol Grip
62214	Grenade Sight (ATK - 75 mm.)

SECTION II -- ACCESSORIES

PART NO.	NAME
62122	Bipod Assembly
62137	Bipod Case
62082	Bayonet Assembly
62138	Bayonet Scabbard
62133	Safety, Non-Automatic Fire
62132	Butt Stock Assembly with Swivel
62118	Rear Swivel Assembly (Butt)
95111	Roll Pin - Rear Swivel
62149	Sling - Butt Stock
62215	Scope Mount Assembly
62142	Scope Assembly
62136	Scope Case

SECTION III - ARMORER'S INSPECTION AND REPAIR KIT

PART NO.	NAME
T 27823	Barrel Remover Fixture
T 27672	Adapter
T 27669	Protrusion Gage Firing Pin
T 27921	Head Space Gage (Field Type)
T 27670	Maximum Bore Gage
T 27442	Bore Drop Plug
T 27726	Fixture Sight Removal and Realigning

104. List of Parts, Accessories and Armorer's inspection and repair kit, from the first Colt manual. The Army soon found that Colt's considered all *of these to be proprietary items which* had *to be purchased from Colt's.*

The Air Force's End Run Around the Army

As mentioned, a major justification for the Ordnance Corps' M14 Light Rifle program was that the one new weapon and the 7.62mm NATO round were supposed to replace four weapons and three different cartridges of the previous small arms "family"; the M1 rifle, M2 Carbine, M3A1 submachine gun and the BAR. While the US Air Force had ceased to be an Army element after World War II, small arms for Air Force ground personnel were still acquired through Army supply channels. The Air Force had been offered the M14, but had pronounced it overly heavy and bulky. Accordingly, SAC-base security forces around the world were still armed with M2 Carbines, for which, ironically, the Army was no longer stocking spare parts.

The friendship between Fairchild president Richard Boutelle and Air Force General Curtis LeMay has already been mentioned in connection with the adoption of the MA-1 survival rifle. Bobby Macdonald later described to the Ichord subcommittee how, armed with a new business arrangement with both Colt and ArmaLite, he had written to General LeMay, by this time the Deputy Chief of Staff of the Air Force, inviting him to a demonstration of the AR-15:

..on the fourth of July [1960], which happened to be Boutelle's birthday, and every year he had quite a party.

His farm was all set up outside Hagerstown, with a skeet field, trap field, archery, pistol ranges, you name it. It was beautifully equipped from a shooting angle.

So LeMay was a friend of Boutelle's, and I suggested that we get together and he have a chance to shoot the rifle as it was presently manufactured. This is when Colt..and we went up there, and I took along three watermelons, and I put [one] out at 50 yards, and the other at about 150 yards, and he shot both of them, and as you probably know, the explosive feature of the bullet takes all the water out of the watermelon. So he walked up to both of them and put his hand down in there and picked this stuff up, and I won't say what he said, but it was quite impressive - he was impressed. So I asked him "Do you want to shoot the other one?" He said, "Hell no, let's eat it." So that's the way we did [it].

The upshot of the demonstration at Boutelle's Maryland farm was General LeMay's offer to recommend the AR-15 as a potential replacement for the Air Force's ageing M2 Carbines. Macdonald quickly sent LeMay three new Colt model 01s, which were soon on their way to the Air Force's main training base at Lackland AFB in Texas, for initial familiarization.

Sadly, however, for some who gave indispensable service to the cause of the AR-15, there was no reward. As Bobby Macdonald later related, "..In the meantime, Colt was taken over by another group of financiers, and in the course of it they fired all the people that I had been doing business with...Fairchild also went through a change in management several times. Based on this rifle, and the F-27 airplane, Mr. Boutelle got fired.."

Colt's First Manual - the "Basic Infantry Weapon, AR-15"

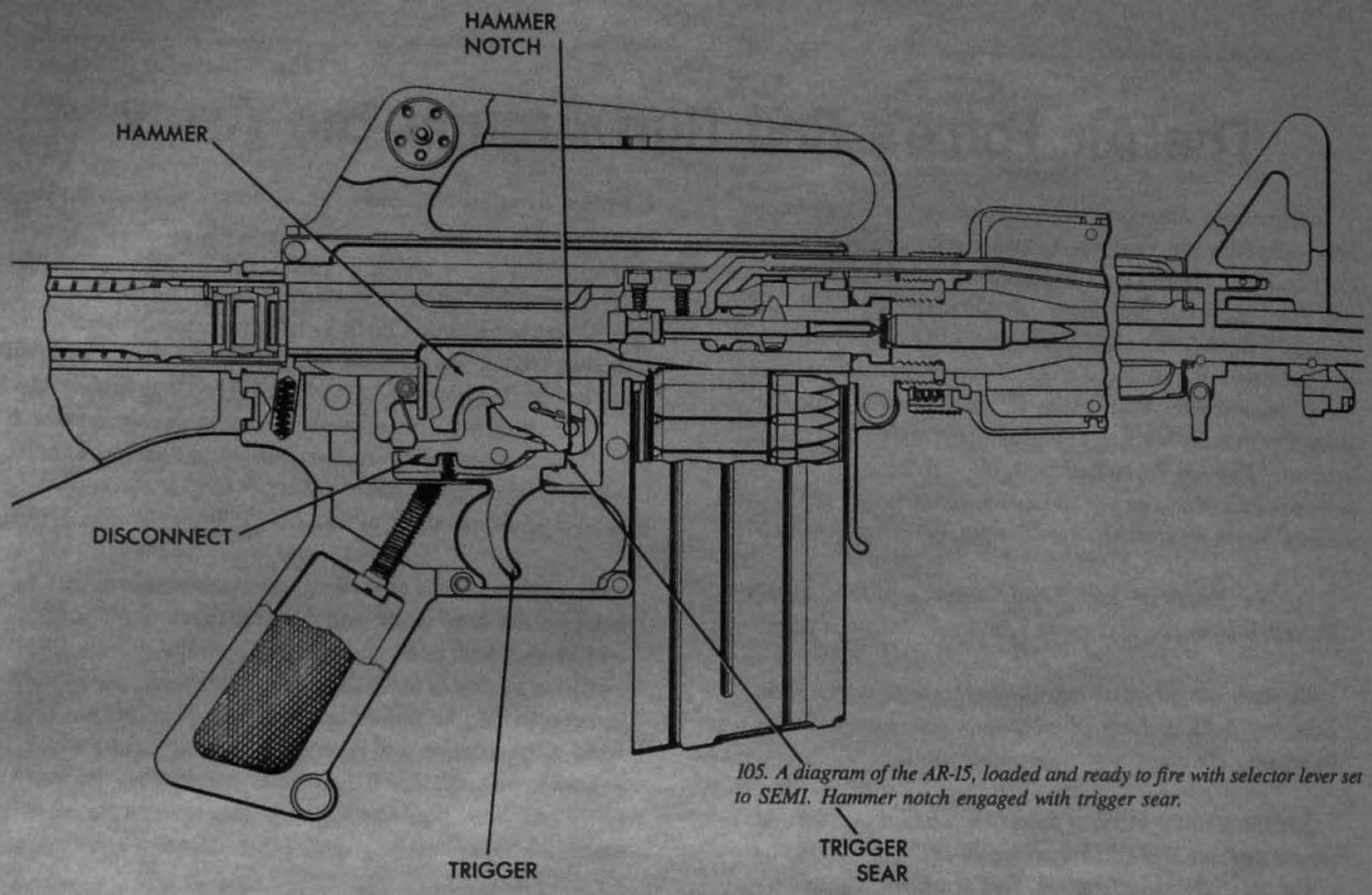
Looking ahead determinedly to the eventual return of military interest in the AR-15, Colt's prepared and published a manual "for the information and guidance of ordnance personnel whose duties involve the use, maintenance and repair of the caliber .223 Basic Infantry Weapon, AR-15". The Colt manual went on to make some most enthusiastic claims for the AR-15, "the most modern light weight combat rifle combining the accuracy of a sniper rifle with the firepower of a machine gun.." as a virtually maintenance-free weapon:

Disassembly, assembly, cleaning and minor repairs may be undertaken by anybody...An occasional simple cleaning will keep the weapon functioning indefinitely. Working parts can be cleaned by wiping with a cloth. The simplicity of field cleaning makes it possible to quickly and easily train a recruit in minimum time.

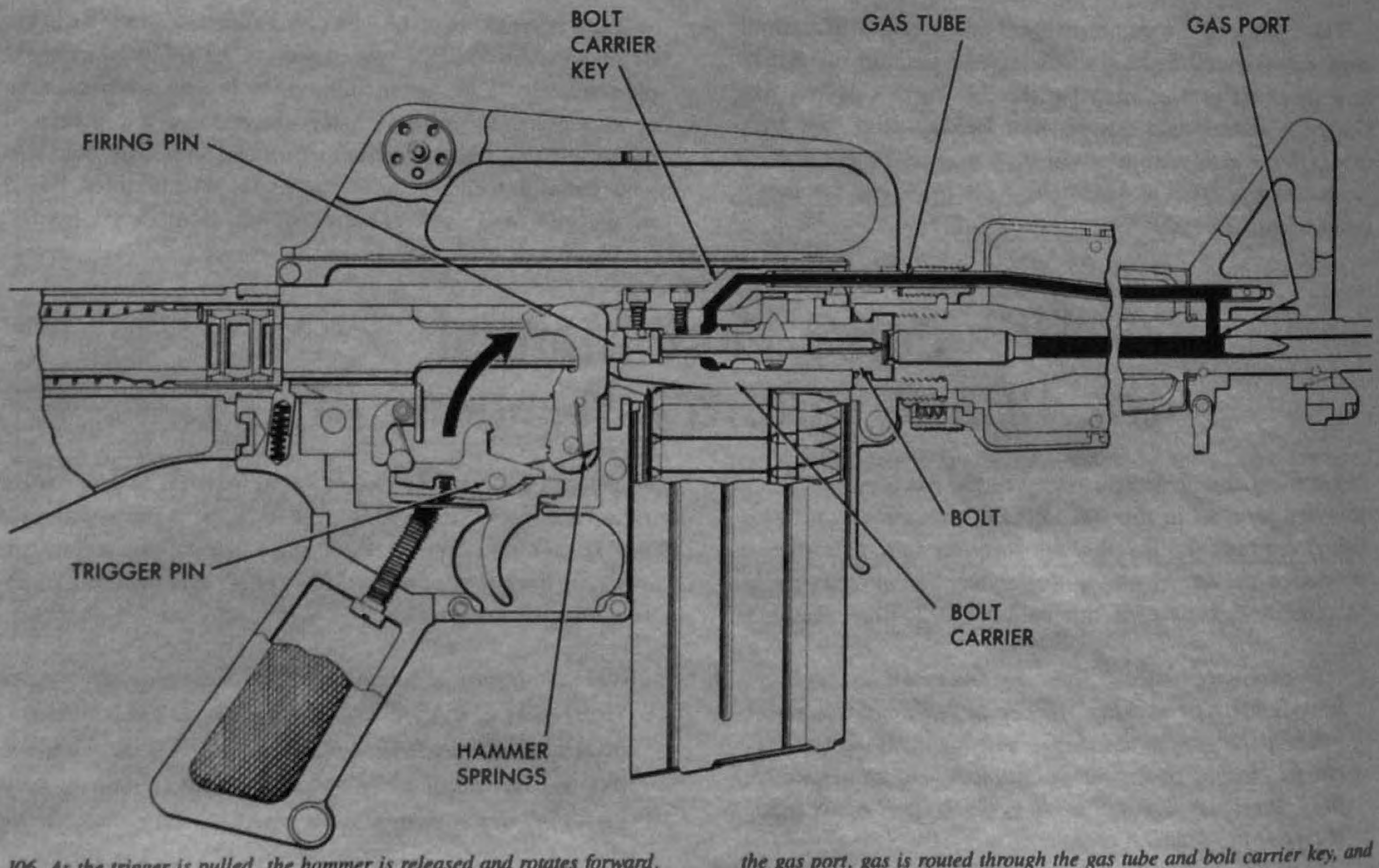
..Corrosion resistant materials facilitate the assembly and interchangeability of parts and reduce the service and maintenance of the Colt AR-15 to an absolute minimum. Firing of the Colt AR-15 with complete absence of lubricants in a chemically cleaned condition has in every country where this test has taken place resulted in a performance far exceeding any requirements.

The Colt AR-15 rifle will fire longer without cleaning or oiling than any other known rifle.

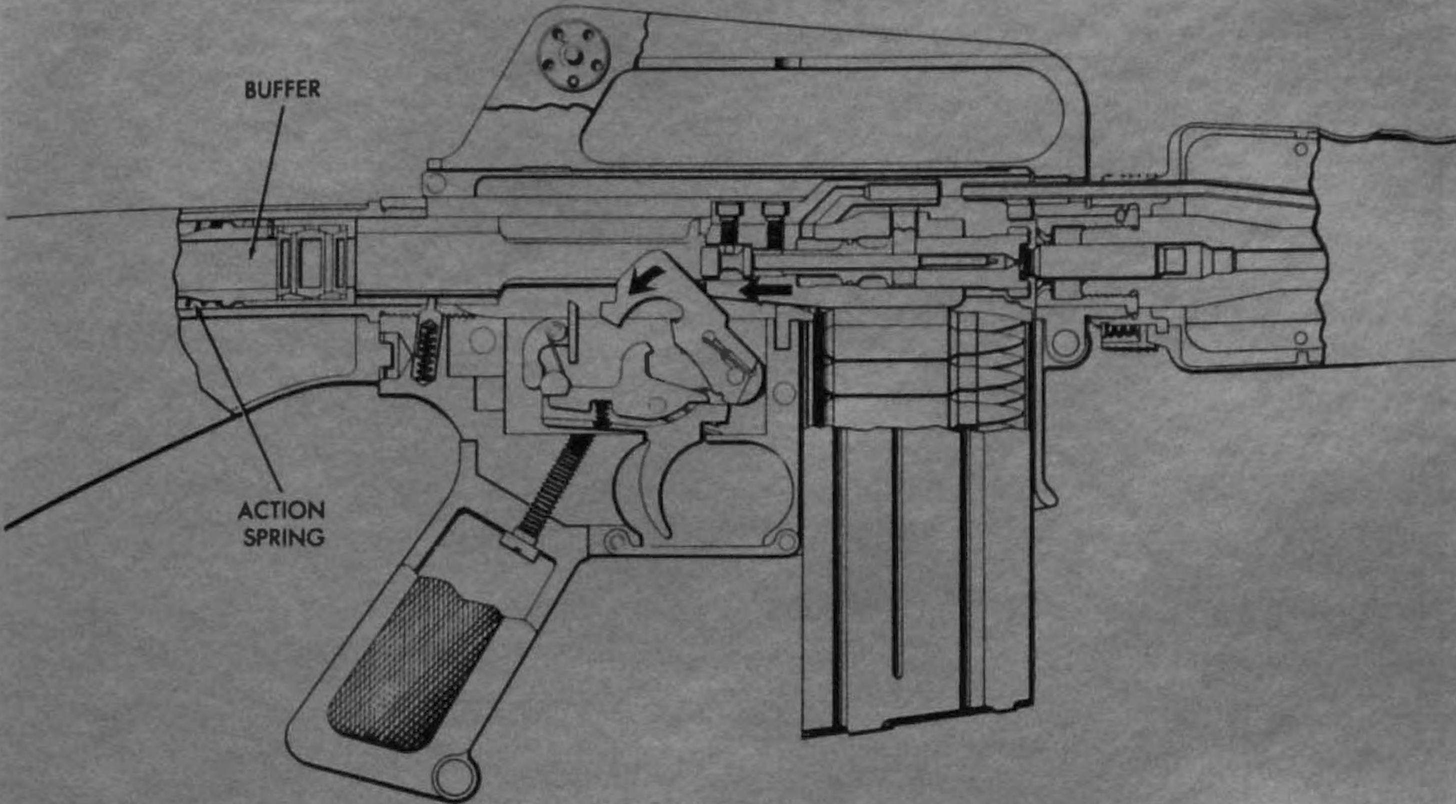
Explaining the Action of the AR-15



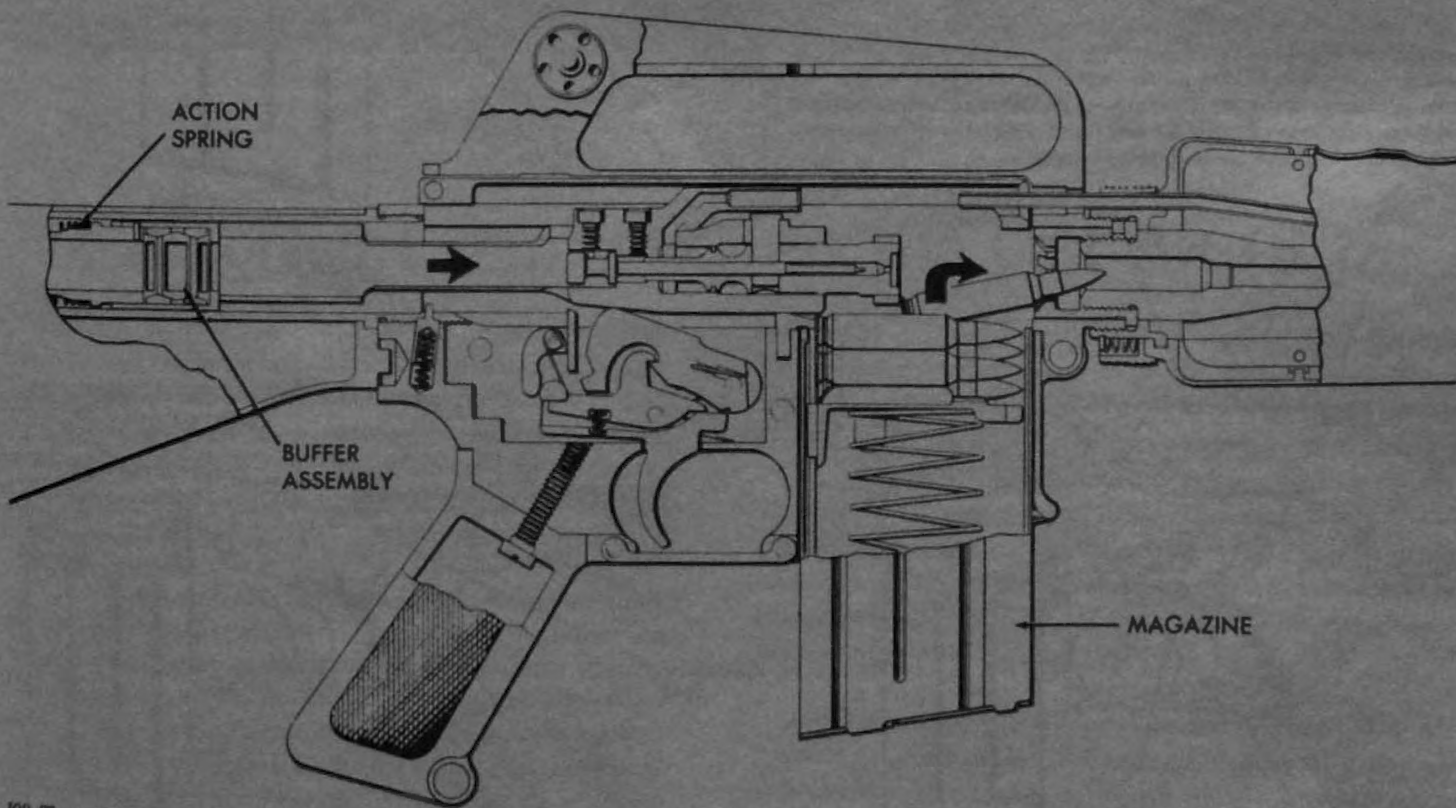
105. A diagram of the AR-15, loaded and ready to fire with selector lever set to SEMI. Hammer notch engaged with trigger sear.



106. As the trigger is pulled, the hammer is released and rotates forward, striking the firing pin and firing the chambered cartridge. As the bullet passes the gas port, gas is routed through the gas tube and bolt carrier key, and into the cylinder formed between the bolt and bolt carrier.

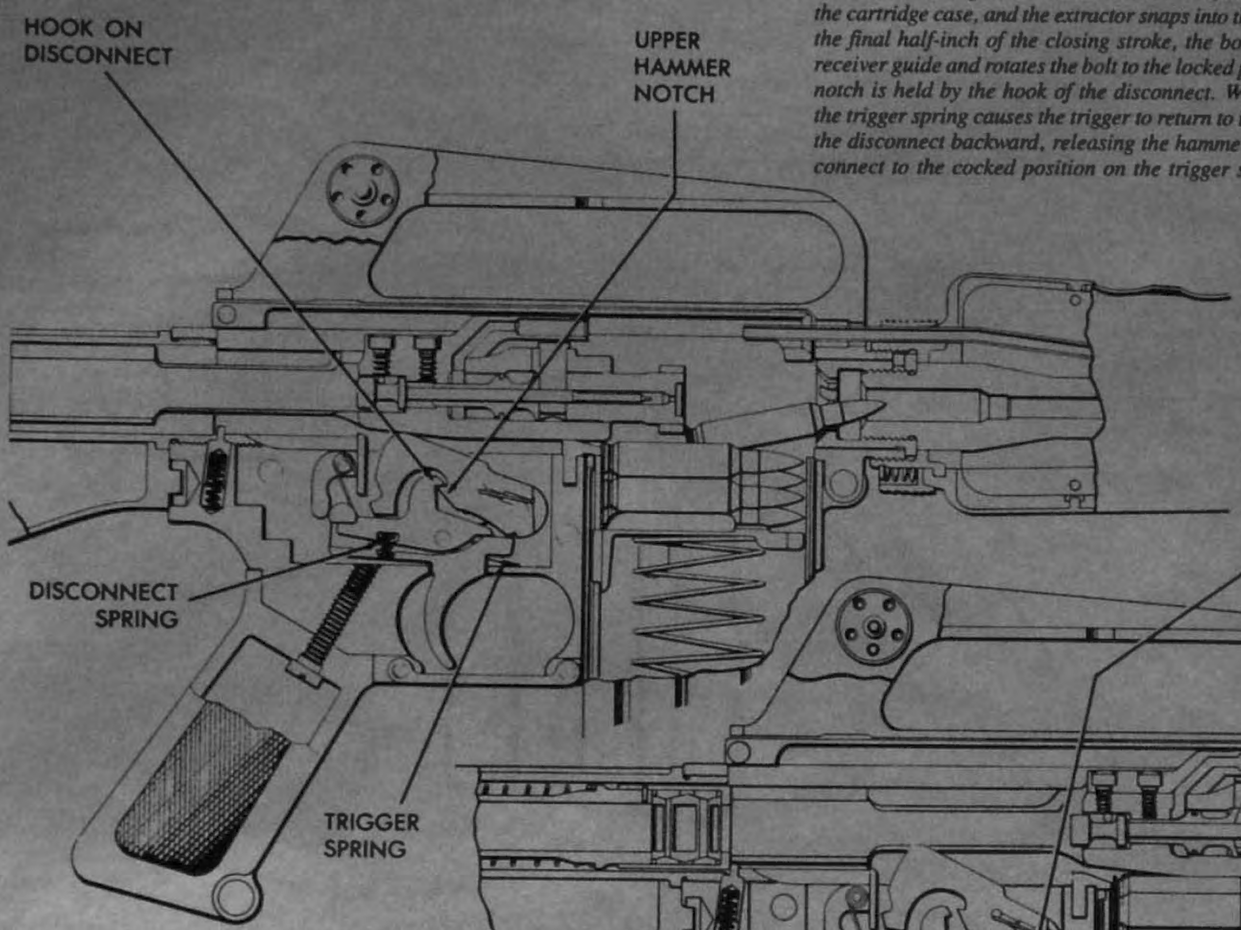


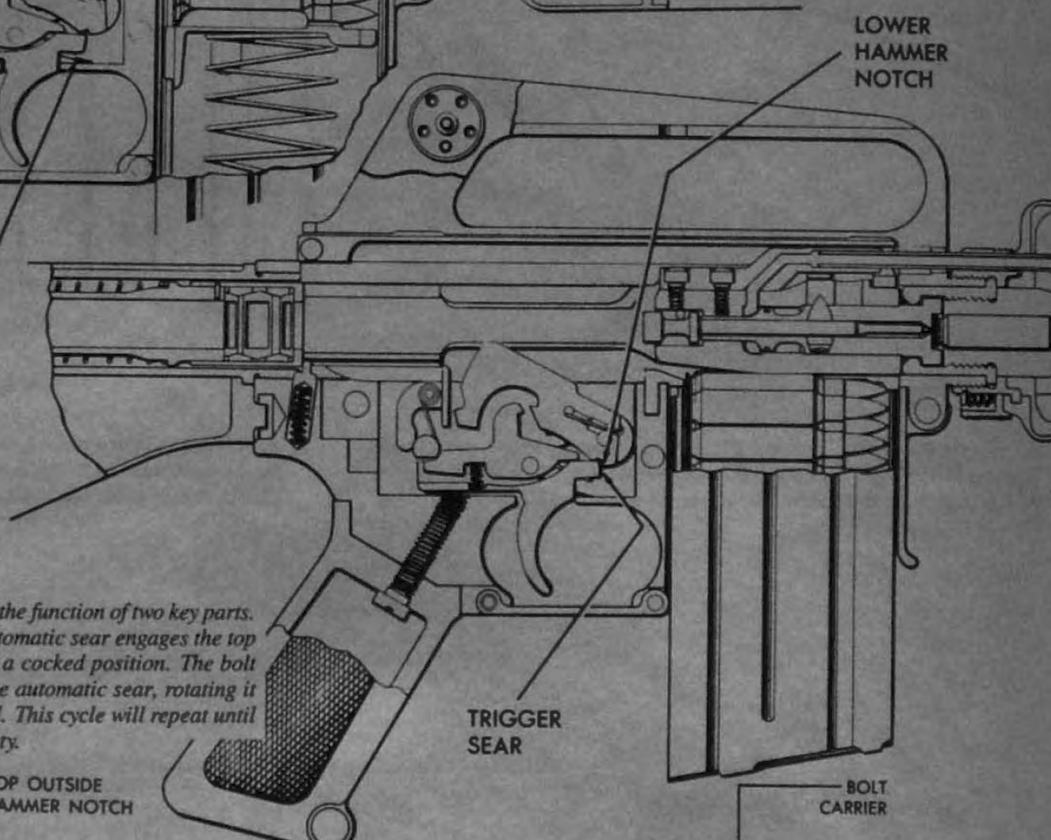
107. Gas pressure in the cylinder drives the bolt carrier to the rear. As this happens, the bolt cam pin rotates the bolt and disengages the bolt lugs from the lugs in the barrel extension. The hammer is returned to the cocked position, and the action spring is compressed. As the bolt and carrier move rearward, the extractor withdraws the spent cartridge case from the chamber, and the ejector throws it out the ejection port.



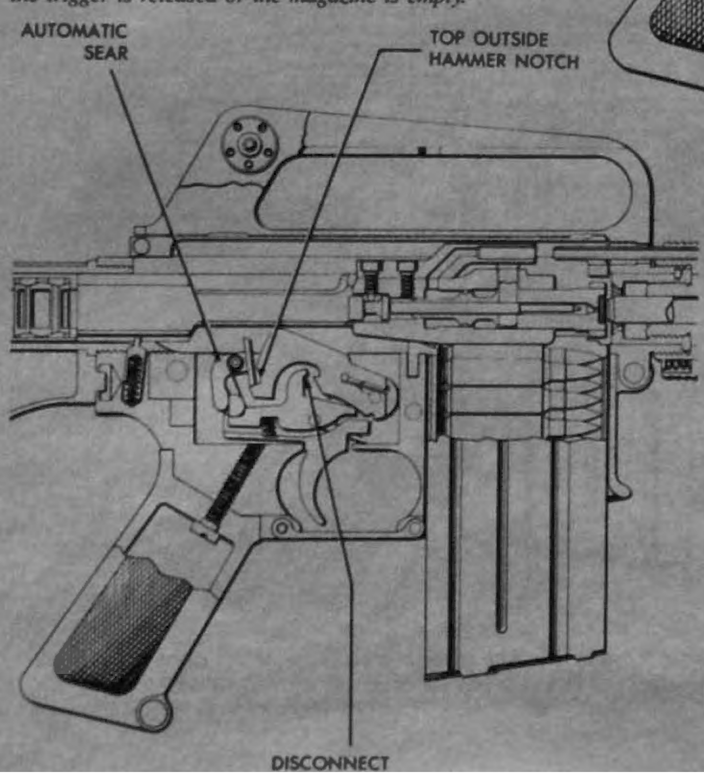
108. The rearward motion of the bolt carrier is arrested by the buffer assembly in the action spring guide. The compressed action spring then forces the bolt carrier forward. The face of the bolt picks up the top cartridge from the magazine, and thrusts it into the chamber.

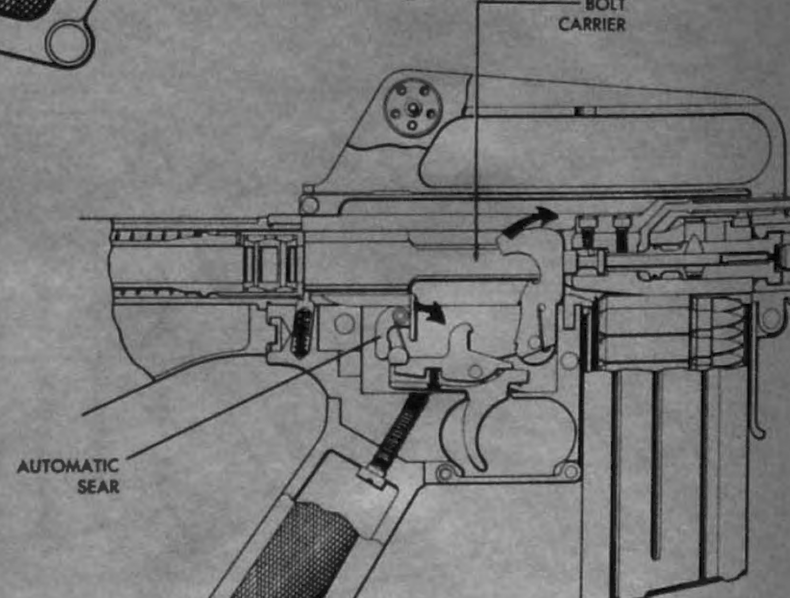
109. As the bolt lugs enter the barrel extension, the ejector is depressed against the cartridge case, and the extractor snaps into the extracting groove. During the final half-inch of the closing stroke, the bolt cam pin moves out of the receiver guide and rotates the bolt to the locked position. The upper hammer notch is held by the hook of the disconnect. When the trigger is released, the trigger spring causes the trigger to return to its normal position, carrying the disconnect backward, releasing the hammer, which drops from the disconnect to the cocked position on the trigger sear.





110. Rotating the change lever to AUTO changes the function of two key parts. On the forward or counter-recoil stroke, the automatic sear engages the top outside hammer notch, holding the hammer in a cocked position. The bolt carrier, in closing, strikes the upper edge of the automatic sear, rotating it and releasing the hammer to fire the next round. This cycle will repeat until the trigger is released or the magazine is empty.





Ill. From Colt's first run of AR-15s: pointing out the "recoil spring guide" on Model 01 serial no. 000300.

A Forced Examination of the Colt AR-15

Meanwhile, in the summer of 1960 just before the famous 4th of July watermelon shoot, Colt's had formally approached Ordnance R&D with a request for a re-test of the AR-15 they now designated the model 01. A number of small but significant improvements had been made in the course of their tooling up for manufacture, they said, which warranted a further look on the part of the Army.

Of course, neither Colt's nor ArmaLite possessed anything like the vast pool of engineering development expertise and resources which were available at the various Ordnance stations. Thus, despite the enthusiasm of their first manual, a good part of Colt's motive was to avail themselves of an otherwise prohibitively expensive full-scale Ordnance engineering evaluation of their "Basic Infantry Weapon" before they got locked in to real quantity production.

To their dismay, Colt's soon received a wire back from Dr. Carten refusing their request, citing as a reason the lack of any military requirement for such an arm. He was soon forced to eat his words, however, for a request arrived at the Pentagon from Lackland Air Force Base, asking Ordnance to qualify the AR-15 as a potential candidate for replacement of the Air Force's obsolescent M2 Carbines. This coincided with a sympathetic ear being given, at the Congressional level, to the plight of the Colt/ArmaLite camp and their "unsaleable" products: suddenly some highly placed people wanted to know about the Ordnance Corps' boycott of ArmaLite weapons.

A chagrined Dr. Carten was directed to arrange the Air Force test without delay, to be run at Aberdeen concurrently with tests on six samples of the AR-10 rifle as made under license in Holland by Artillerie-Inrichtingen. In fact, it appears that the whole event had already been adroitly turned into some first-rate exposure for the AR-15, with the Ordnance Corps footing the bill:

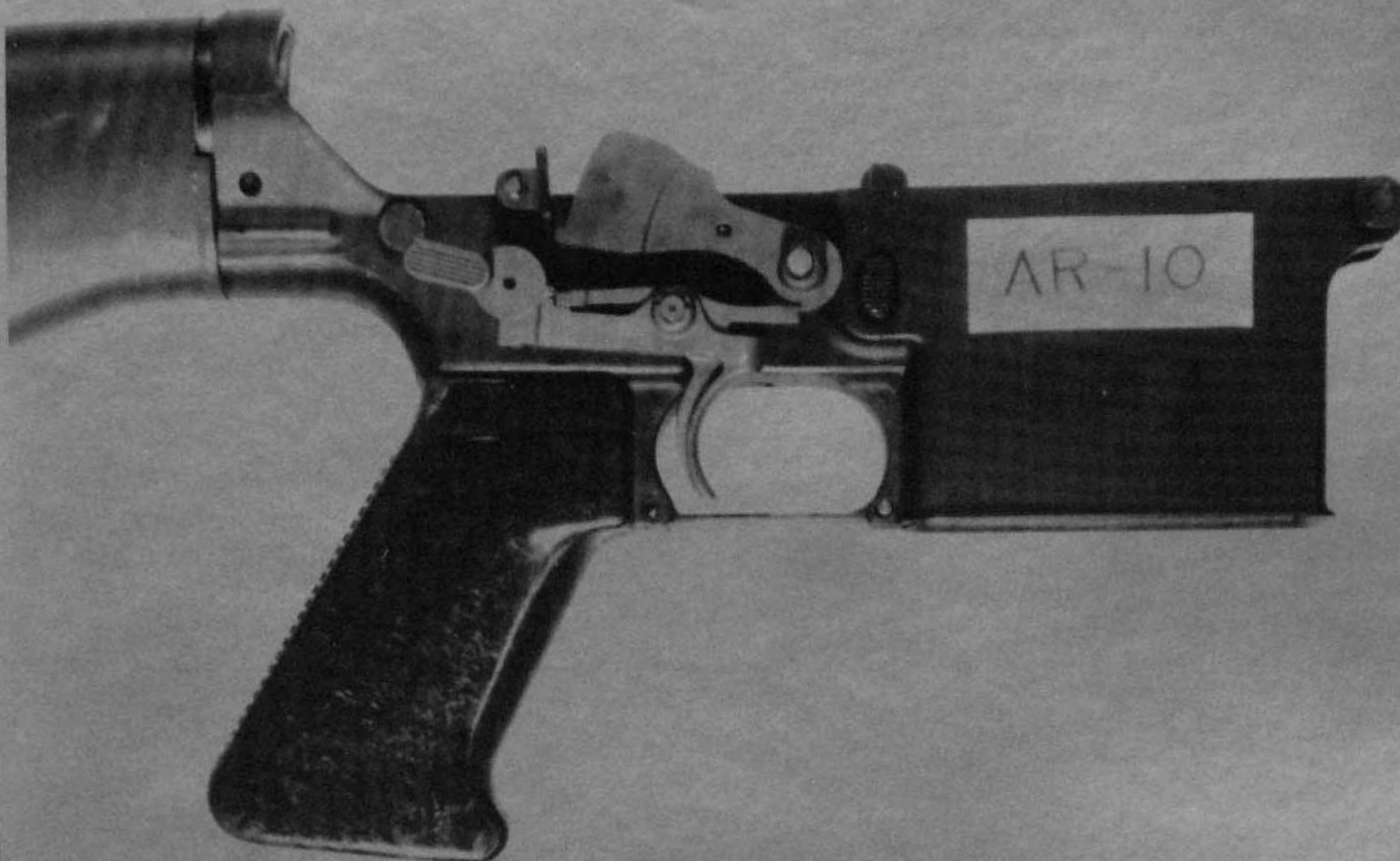
112. Retracting the bolt on Colt's AR-15 serial no. 000300. Note the "R" and clockwise arrow markings on the early Colt rear sight elevation knob.

1960 SEP 12

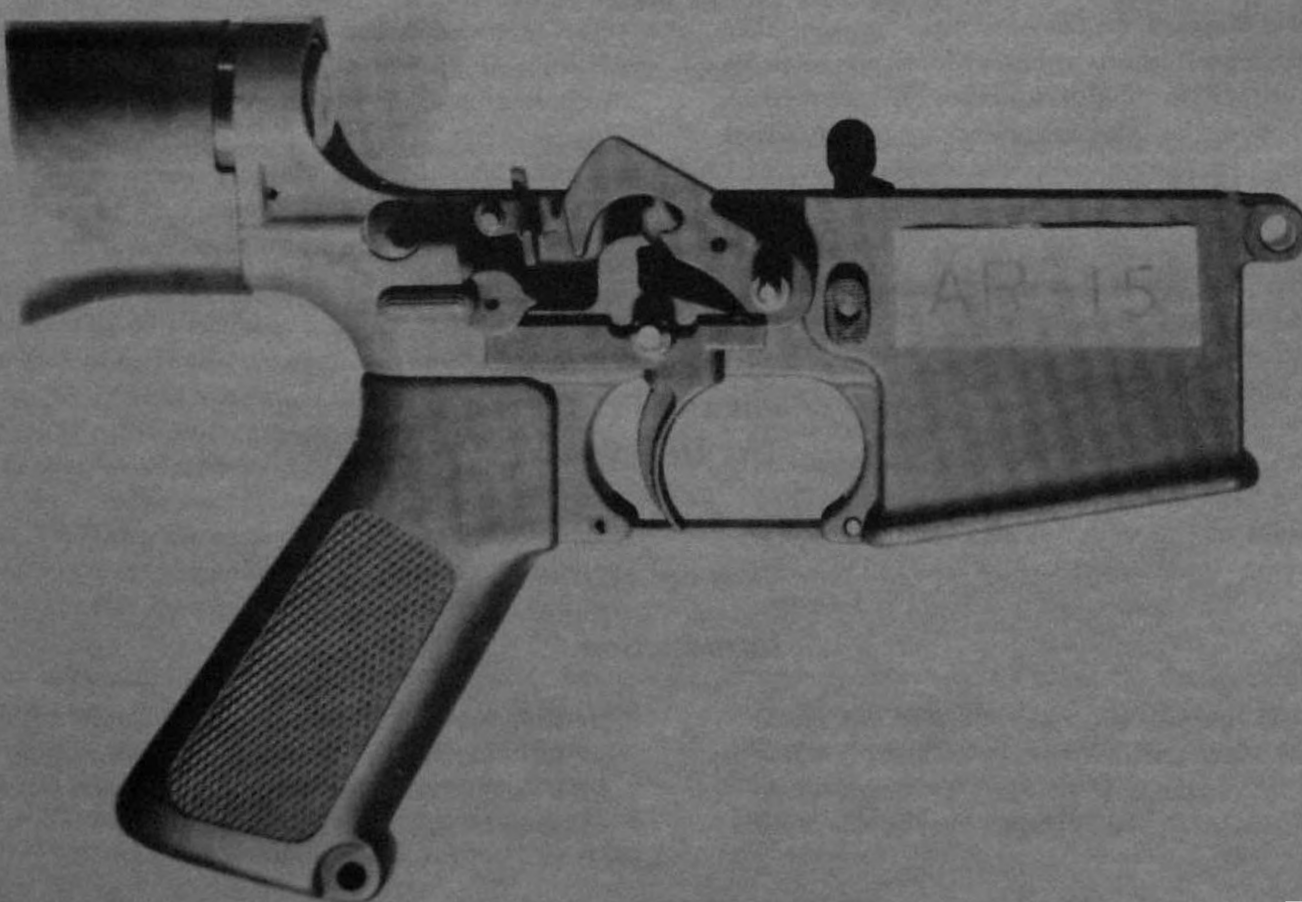
UNCLAS ORD 10508 FOR D&PS COL DUBIA FROM ORDTS CARTEN

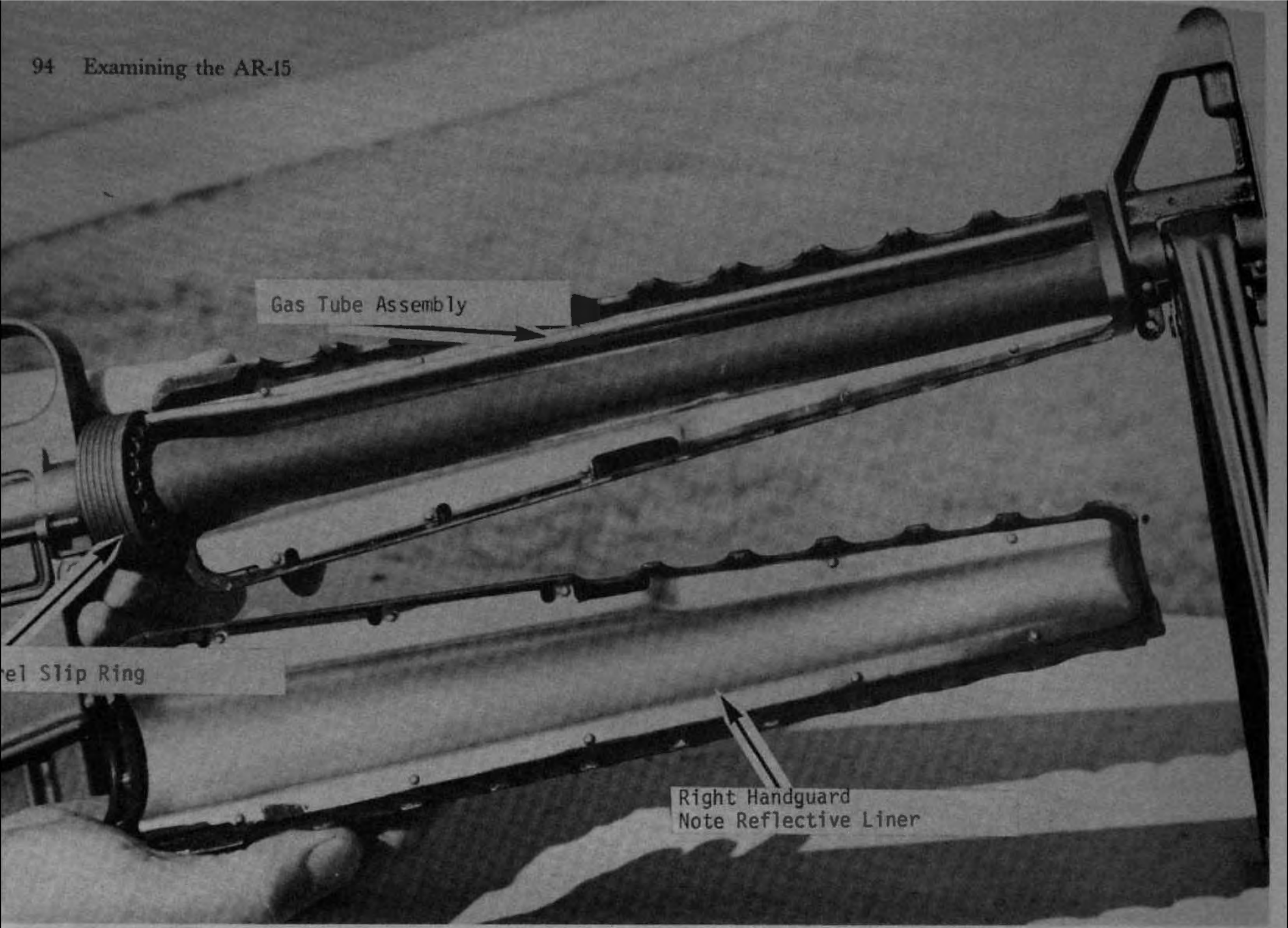
..AR-15 CALIBER .223 RIFLES AND AMMUNITION WILL BE SUBMITTED TO YOUR STATION IN THE IMMEDIATE FUTURE BY COOPER-MACDONALD, INC. REQUEST FINAL ENGINEERING TEST OF THIS WEAPON BE CONDUCTED DURING THE SAME PERIOD THAT SIMILAR TESTS ARE BEING CONDUCTED ON THE AR-10 7.62MM RIFLE. REQUEST AMMUNITION PERFORMANCE TRIALS PREVIOUSLY CONDUCTED WITH THE AR-15 RIFLES ALSO BE INCLUDED.

REQUEST YOUR STATION MAKE AVAILABLE TO THE COMPANY FACILITIES FOR DEMONSTRATION OF AR-15 RIFLES TO INTERESTED MILITARY PERSONNEL. DATE FOR THIS DEMONSTRATION IS TENTATIVELY SET FOR 26 SEPTEMBER 1960. GENERAL LEMAY, DCS, USAF, AND LT GEN TRUDEAU, CRD, ARE EXPECTED TO ATTEND, ALONG WITH OTHER REPRESENTATIVES OF AIR FORCE AND ARMY



113. Comparison of trigger mechanisms. Above: an early ("Cuba/Sudan") Dutch-made AR-10. Below: Colt model 01 AR-15. *Photo courtesy Jean Huon*





114. Colt model 01 AR-15 barrel, gas tube and handguard assemblies.

As noted in chapter 3, the final versions of two other Aberdeen engineering test reports by Larry Moore, one being No. DPS 101 *A Test of Rifle, AR-10* of November 1960 and the other as discussed below, contain no recommendations or conclusions. Certainly from Dr. Carten's viewpoint, none were required, in the absence of any formal Army interest in either arm: he was simply giving Cooper-Macdonald and the Colt/ArmaLite people as little encouragement as possible, while providing the Air Force with a record of tests conducted and leaving any conclusions up to the trials team at Lackland.

Some of Larry Moore's interesting comments regarding the three Colt model 01 AR-15s he tested, serial numbers 000614, 000682 and 000835, are reprinted below:

Aberdeen Proving Ground
Development and Proof Services
No. DPS 96

A Test of Rifle, Caliber .223, AR-15

November, 1960

Introduction

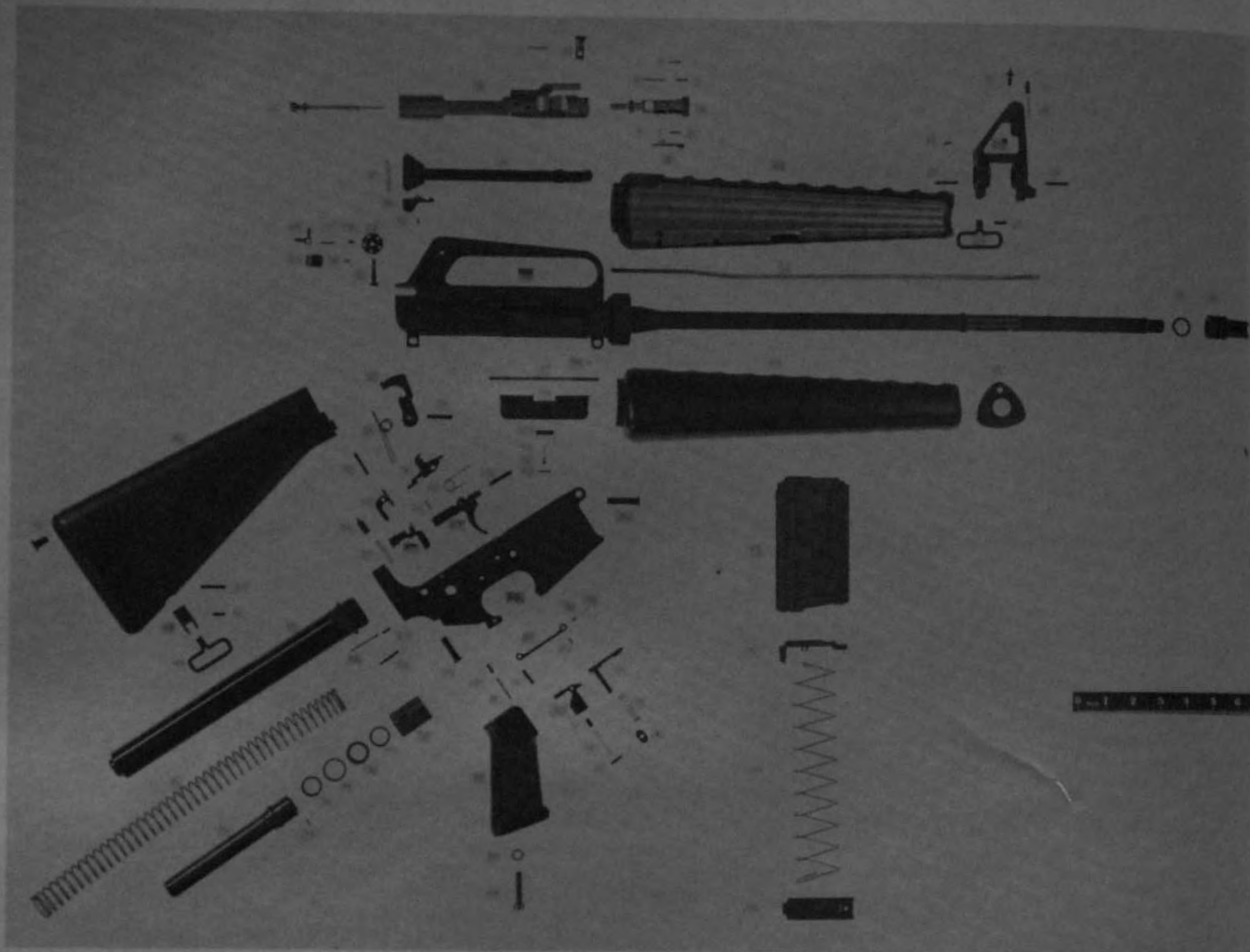
The AR-15 rifle was previously tested at this station between 20 March and 21 November 1958. The results of that test are contained in [the fifty-seventh report on Ordnance Project TS2-2015; chapter 3]. The rifle tested previously was an experimental model produced in a limited quantity. The rifle submitted for this test was mass produced and it incorporated various minor design changes from the experimental rifle..

115. Closeup of receiver markings of Colt AR-15 serial no. 000614, used in the Aberdeen "Test of Rifle, Caliber .223, AR-15" September, 1960.
Photo credit: Eric Long, Smithsonian Institution

Abstract

Three rifles were subjected to the light automatic rifle test and two rifles were subjected to additional accuracy tests. A total of 24,443 rounds were fired. The AR-15 rifle, which has a weight of 6.92 pounds when fully loaded and an overall length of 38.8 inches, fires Cartridge, caliber .223. The average velocity of the 55-grain bullet at 78 feet was 3,104 fps. In the 100-yard bench-rest accuracy test the average mean radius for 10-round targets was 1.5 inches. The average number of rounds fired semi-automatically in one minute in the rate-of-aimed-fire test was 84.2 and the average number of hits obtained on the "E" target at a range of 100 yards was 77.8. During automatic firing in this test, the average number of rounds fired was 128.7, and the average number of hits was 41.3. The average malfunction rate with the rifle held normally was 0.25 per hundred rounds. Only ten parts were broken in firing 18,000 rounds in the endurance test. One of these parts, an extractor spring, was broken during disassembly of the extractor. The AR-15 rifle gave near-normal performance in the unlubricated, dust, extreme-cold and rain tests, and it completed the mud test. [A modified rain test was also conducted, wherein the bolt was retracted slightly with the muzzle held down to facilitate drainage, before firing]. A cook-off occurred after firing 140 rounds in 54 seconds, but no cook-off occurred in firing 120 rounds in 39 seconds. When fired with a telescopic sight from a bench rest at 100 yards two rifles gave an average mean radius of 1.1 inches for four 10-shot groups from each rifle with each of two lots of ammunition.

Even in the absence of conclusions and recommendations it appears from the above that the performance of the 1960 Colt AR-15s, especially in the scoped-accuracy and adverse condition tests, was little short of phenomenal. Indeed, a perusal of other standard light rifle tests, such as are to be found in previous Collector Grade books, will show the above results superior to most if not all the developmental weapons of the period, including the M1 and T44E4 "control" rifles. However, even though Dr. Carten's report to the Chief of R&D grudgingly summed up the AR-15 as only "reasonably satisfactory", the AR-15 was approved for Air Force trial as requested.



116. Fig. 9 from Aberdeen's 1960 trial: disassembled view of Colt AR-15 serial no. 000614. *Aberdeen Proving Ground photo, courtesy James Alley*

The Air Force Attempts to Buy the AR-15

There followed a series of USAF firing tests at Lackland, wherein the AR-15 was shot in comparison with the M2 Carbine and the M14. Gene Stoner himself proudly recorded that 43% of the firers qualified as expert with the AR-15 as opposed to only 22% with the M14. This favorable experience, coupled with the results from Aberdeen, convinced General LeMay that the AR-15 was indeed the rifle the Air Force was looking for. Accordingly, he requested authority to buy a cumulative total of 80,000 rifles, to be obtained over the period of several years, during which time the M2 Carbines would be phased out. As it turned out, this was the beginning of a very happy relationship between the Air Force and the AR-15, but it took General LeMay three determined tries to get his purchase request approved.

In the summer of 1961 Deputy Defense Secretary Roswell Gilpatrick proposed to include 8,500 Colt AR-15 rifles as part of the Air Force's slice of that year's fiscal "pie", subject to Congressional approval, but the watchdog subcommittee on DOD appropriations was not convinced that the Air Force's need was sufficiently pressing to justify another rifle in the system, and the request was denied. General LeMay next brought the matter up in a meeting with President Kennedy that December, after the President had first seen an AR-15 at a Sea Power demonstration during the fall, but again with no success.

Meanwhile, "optimum platoon" trials by the Combat Development Experimentation Center (CDEC) were in progress at the Hunter-Liggett military reservation, Fort Ord, California. Early CDEC findings, published after trials with the first bipod-equipped, ArmaLite-made AR-15s in 1959, had indicated that a 5- to 7-man squad armed with a light weight, high velocity rifle like the AR-15 would have a greater hit and kill potential than eleven men equipped with the M14.

As we shall see, by the time General LeMay's purchase was finally approved in May of 1962 events in Southeast Asia had heated up to the point where the original 8,500 Air Force AR-15s formed much the smaller part of a "package" including over 20,000 rifles for Navy SEAL teams, some special South Vietnamese Army units and their US advisors.

Rifle by Colt - Barrel by Winchester

A key figure in the development of the AR-15 at Colt's was Robert E. Roy, who today is the firm's director of military sales. Rob Roy recalls that his first job after joining the firm in 1961 was to devise and supervise the installation of .22 caliber barrel rifling machinery, as prior to that time Colt's had not possessed the capability to produce rifle-length barrels. In fact, the first 18,000 AR-15 barrels were subcontracted to Winchester, where they were broach-rifled with a 14" rifling twist. Colt's subsequent barrels were button-rifled, a superior rifling process which produced more uniform lands and grooves.

117. From the first Colt AR-15 brochure, produced in a desperate attempt to interest somebody - anybody - in the merits of the AR-15's "unmatched superiority".

Chapter Five
FIRST BLOOD

When President Kennedy turned down the Air Force's second AR-15 request in December 1959, the people at Colt's, by then part of the Fairbanks Whitney conglomerate, were in dire straits indeed. They had gambled virtually everything on the AR-15 and, with seemingly every avenue to mass-market sales at home *or* abroad effectively blocked, the Firearms Division was just barely hanging on by the fingernails.

Doing everything possible to expose the Ordnance clamp-down on the AR-15, Bobby Macdonald kept up a flurry of letters to well-placed Congressmen and even the Secretary of Defense himself. By this time, however, the trouble was that any official cognizance of the AR-15 would automatically beg numerous questions concerning the conduct, or worse, the validity, of the turbulent M14 rifle procurement program. As in 1940, when the Senate appropriations subcommittee had refused Melvin Johnson's last impassioned appeal in the face of the 100 M1s rolling daily out of Springfield Armory, 1961 seemed just too far down the road with the M14 to allow the consideration of any other course of action.

At length, the stalemate was broken by the hand of fate. Amid an escalating atmosphere of US armed forces' "advisor" activity in support of the Army of the Republic of South Vietnam (ARVN), in Bobby Macdonald's words: "..Finally we got the ARPA order, December 27, 1961, for 1,000 rifles."

OSD, ARPA and Project AGILE

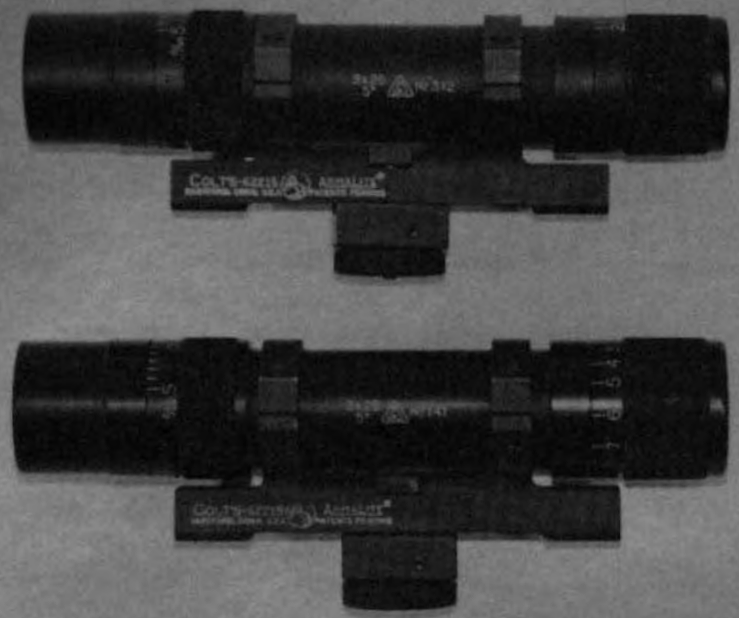
Among other changes of a generally intellectual nature ushered in by President Kennedy came fateful new dimensions of power for the civilian Office of the Secretary of Defense (OSD). To head this office Kennedy appointed Robert Strange McNamara, a retired Army Air Force Lieutenant-Colonel who had been a special consultant to the War Department during World War II. More recently he had gained visibility as a senior executive, then president, and finally a director of the Ford Motor Co. The time, coincidentally, was the very dawning of the computer age. Secretary McNamara, himself no stranger to this powerful new analytical "tool", soon surrounded himself with an eager young team of Ph.D. systems analysts, all implicit believers in the computer's unprecedented forecasting abilities.

Bill Davis, late of Aberdeen's D&PS, records that he left Aberdeen in 1959 to take up new duties as the Superintendent of Frankford Arsenal's newly designated North American Regional Test Center for NATO small arms ammunition, sited at Fort Dix, New Jersey. He records the impact, as he saw it, of Robert McNamara's ascendancy to power as the Secretary of Defense:

Secretary McNamara had come to power in 1961, and as is customary, had filled the appointive offices such as undersecretaries, deputy undersecretaries etc., with people of his own choosing, who held views entirely in consonance with his own. Not stopping there, however, he had greatly expanded the headquarters organizations at the OSD level, creating many new high-level positions, to be filled ostensibly with career military and civil servants, but in fact..filled mostly by newcomers to the defense establishment, fresh from Mr. McNamara's previous academic and intellectual environs ..such as the "think tank" Rand Corporation..

McNamara's remedy was not simply to correct the faults that he perceived in the traditional defense institutions as he found them, but to destroy the infrastructure itself, and rebuild within the hollow shell a system more in conformity with his own ideas of management..

McNamara's contempt for the Ordnance professionals was undisguised at the less sophisticated lower levels outside Washington, and its impact was soon felt, as the influence of his emissaries spread to the technical installations such as Springfield Armory, Frankford Arsenal and Rock Island. [These people] had no previous professional experience in the field of small arms, though some apparently had a bit of the hobbyist's fascination with the technical aspects of guns and ammunition. Their qualifications consisted of, and apparently were limited to, advanced academic degrees, supreme confidence in their own intellectual superiority, virtually absolute authority as designated representatives of OSD, and a degree of arrogance such as I have never seen before or since.



118. Left side view of two Delft Optics AR-10-type 3x25-power telescopes (fig. 58) adapted as the "TTL-80", the first AR-15 scope sight. Note the different types of finish; serial no. 312 (above, dull); and serial no. 141 (below, bright anodized) in early Colt-made mount (part no. 62215).
Bob Miller collection, photo by Roy Arnold

119. Fig. 2-5 from the first USAF manual for the AR-15 rifle, illustrating the inverted-post reticle of the Dutch TTL-80 scope.

Defense policy during the Eisenhower administration had been based on the rather black-and-white theory of "massive retaliation", wherein the infantry soldier's future role had been reduced to one of merely "mopping up" after a nuclear clash. However, the resulting buildup of atomic bombs made both East and West increasingly reluctant to test each other's awesome capabilities in an all-out war. The Kennedy team therefore inherited a world wherein a struggle for world domination continued, somewhat less cataclysmically but still unabated, under the nuclear "umbrella". Guerrilla (literally "little war") and counterinsurgency operations, and the specialized arsenal of conventional small arms they required, were definitely on the new list of priorities.

The Advanced Research Projects Agency (ARPA) had been formed within the Defense Department in 1958, with a remarkably free-handed mandate to devise and direct "long-range, basic research" for a defense research and engineering unit, primarily in the ballistic missile arena. ARPA got a new lease on life and an expansion of mission with the Kennedy administration's interest in improving US ability to support a foreign ally in a "limited" war. In the spring of 1961 ARPA's Project AGILE was approved, to supply "research and engineering support for the military and paramilitary forces engaged in or threatened by conflict in remote areas of the world". ARPA managers proceeded to establish and staff two Combat Development Test Centers in troubled Indochina; one in Bangkok and the other in Saigon.

Because of the controversy which has surrounded this weapon, particular care was exercised to insure that the tests were

With the "remote areas" of Project AGILE thus defined as populated by small-statured Southeast Asians, it wasn't long before the tireless Bobby Macdonald had convinced Col. Richard Hallock, on loan to the AGILE team from the Army, that the light, lethal but soft-recoiling AR-15 was just the rifle ARPA was looking for. By late summer ARPA had officially requested over 4,000 AR-15s to support a proposed full-scale test of the AR-15 in conjunction with special US advisor-guided units of the South Vietnamese Army. This request was denied, on the grounds that M2 Carbines were just as suitable for small-statured troops, *and* were available from storage. Undaunted, ARPA boiled the whole idea down to what they could afford: a limited range of tests in Saigon, in October 1961, with ten Colt AR-15s. The number of rifles might have been small, but the enthusiastic reaction of the Vietnamese and their American advisors alike who handled and fired the AR-15s was just as Bobby Macdonald had predicted.

Armed with these positive results, ARPA re-submitted its original request, clearly stating that the AR-15s required were to be used to arm special US advisor units and their Vietnamese allies only, and were not to be considered as a general issue item for regular US troops. In December 1961 Secretary of Defense McNamara approved an ARPA buy of 1,000 rifles, thus saving Colt's from almost sure financial disaster and also setting the stage for the most influential yet controversial document so far in the history of the already controversial AR-15. Indeed, the project's assistant director was moved to preface the final AGILE report from ARPA's Vietnam field office as follows:

objective, thorough and adequately documented, and to insure that valid data and conclusions were derived therefrom...

Advanced Research Projects Agency
Research and Development Field Unit
31 July, 1962

Report of Task 13A, Test of ArmaLite Rifle, AR-15

Purpose

The purpose of this test was to determine if the AR-15 rifle is compatible with the small stature, body configuration and light weight of the Vietnamese Soldier and to evaluate the weapon under actual combat conditions in South Vietnam. At the request of MAAG [Military Assistance Advisory Group], Vietnam, the scope of the test was expanded to include a comparison between the AR-15 and the M2 Carbine to determine which is a more suitable replacement for other shoulder weapons in selected units of the Republic of Vietnam Armed Forces (RVNAF).

Background

The problem of selecting the most suitable basic weapon for the Vietnamese soldier is complicated by his small stature and light weight. The average soldier stands five feet tall and weighs ninety pounds. Principle US weapons presently issued to Vietnamese troops include the M1918A2; the Thompson Sub-Machine Gun, Caliber .45; and the US Carbine, Caliber .30, M1.

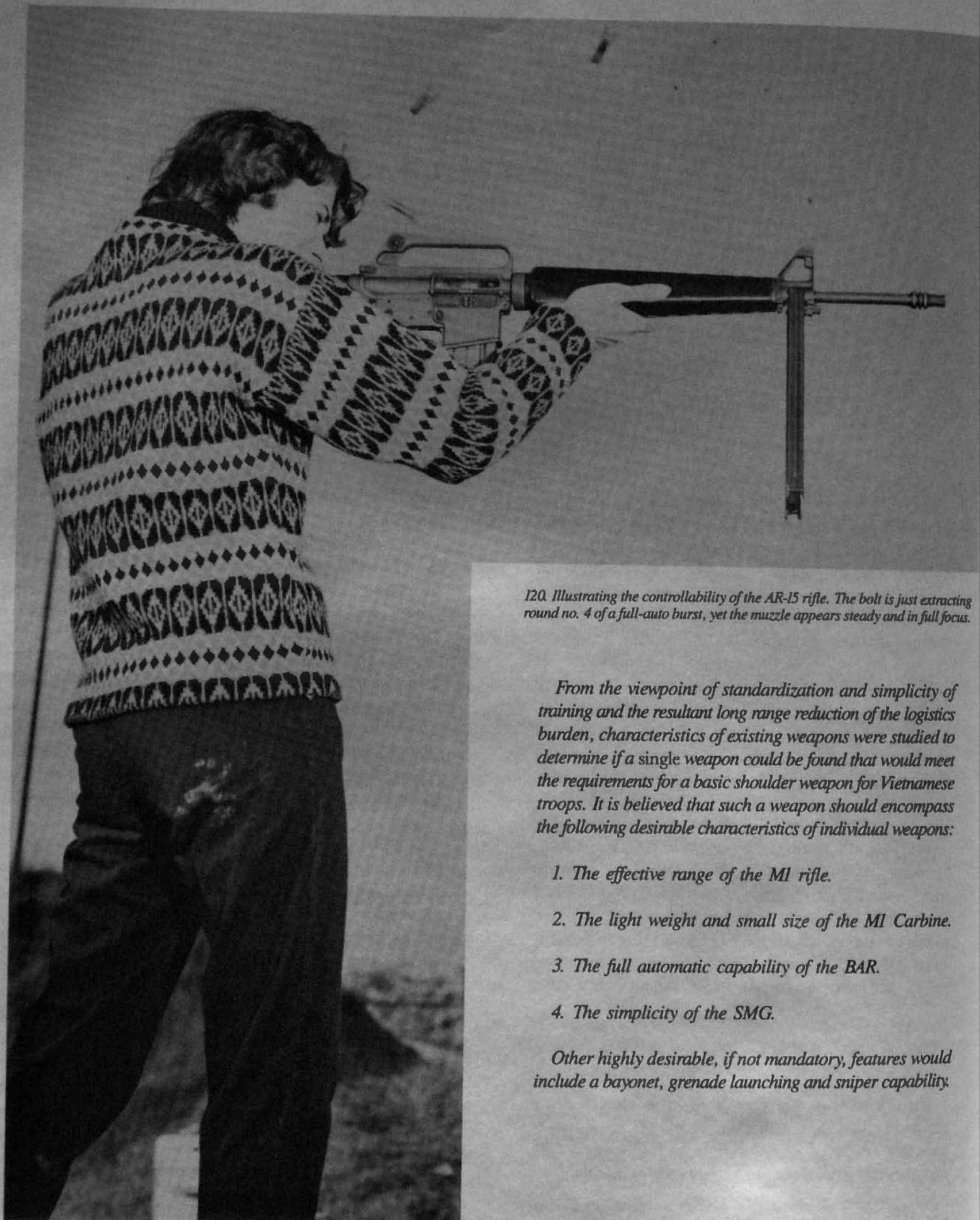
Because of its availability and the results of extensive studies and previous testing by military agencies, the Colt ArmaLite AR-15 rifle was selected in July, 1961 as the most suitable weapon for initial tests. This weapon was developed by the ArmaLite Division of Fairchild Aircraft Corporation to meet the military characteristics for a lightweight rifle utilizing the high velocity small caliber principle. It was first tested by the US Army Infantry Board in 1958. Since then, the weapon and its ammunition have undergone extensive engineering and service tests by: Aberdeen Proving Ground; the Combat Development Experimentation Center, Fort Ord, California; and the US Air Force at Lackland Air Force Base, Texas. The rifle, with several modifications resulting from these tests, is presently being manufactured by Colt's Patent [Firearms] Manufacturing Company, Hartford, Connecticut. (Prior to the completion of this report, the US Air Force adopted the AR-15 as its basic shoulder weapon, replacing the M2 Carbine, the Browning Automatic Rifle and the M3 Sub-Machine Gun).

Based upon favorable observations of the AR-15 by both US Advisors and RVNAF Commanders following limited firing demonstrations conducted in Vietnam during August 1961, weapons were requested in numbers sufficient to conduct a full-scale combat evaluation of the AR-15 by selected units of the RVNAF. In December 1961, the Secretary of Defense approved the procurement of 1,000 AR-15 rifles, necessary ammunition, spare parts and accessories for evaluation.

OSD/ARPA negotiated a contract with the firm of Cooper-Macdonald Inc., of Baltimore, Maryland, for procurement and air shipment of all materiel. The first shipment was received on 27 January 1962 and subsequent increments arrived approximately every three weeks until the contract was fulfilled on 15 May 1962. Operational evaluation and testing began on 1 February and terminated on 15 July 1962.

Discussion

The extremely mobile type of offensive warfare being stressed by US Advisors in Vietnam and the small stature and light weight of the Vietnamese soldier places a high premium on small, lightweight weapons. In addition, the violent short clashes at close ranges which are characteristic of guerrilla warfare in Vietnam makes it highly desirable to have a dependable weapon capable of producing a high rate of accurate and lethal full automatic fire.



120. Illustrating the controllability of the AR-15 rifle. The bolt is just extracting round no. 4 of a full-auto burst, yet the muzzle appears steady and in full focus.

From the viewpoint of standardization and simplicity of training and the resultant long range reduction of the logistics burden, characteristics of existing weapons were studied to determine if a single weapon could be found that would meet the requirements for a basic shoulder weapon for Vietnamese troops. It is believed that such a weapon should encompass the following desirable characteristics of individual weapons:

1. *The effective range of the M1 rifle.*

2. *The light weight and small size of the M1 Carbine.*

3. *The full automatic capability of the BAR.*

4. *The simplicity of the SMG.*

Other highly desirable, if not mandatory, features would include a bayonet, grenade launching and sniper capability.

Details of the Combat Evaluation of the AR-15

Selected Vietnamese units which had previously been engaged in considerable combat were issued AR-15 rifles and ammunition for use against the Viet Cong... [as follows:]

Unit	*AR-15 Rifles*	*Ammunition*
7th Infantry Division	*100*	*50,000 rounds*
Rangers	*100*	*50,000 rounds*
Airborne Brigade	*390*	*195,000 rounds*
VN Marines	*100*	*50,000 rounds*
VN Special Forces	*100*	*50,000 rounds*
Special Battalions	*125*	*120,000 rounds*
5th Infantry Division	*40*	*25,000 rounds*
Father Hoa	*10*	*10,000 rounds*
Total	*965*	*550,000 rounds*

Summary of Tests

To accomplish the stated purpose of this test, it was divided into two parts. One part was a combat evaluation of the AR-15 in which the weapons were issued to specially selected ARVN units for use in their operations against the Viet Cong. Along with the rifles and ammunition, Vietnamese Unit Commanders and US Military Advisors were given weapon preference and operational questionnaires and requested to complete and return them after training and combat use of the AR-15...

The other part of the test consisted of a comparison between the AR-15 rifle and the M2 Carbine. Areas in which the two weapons were compared included: physical characteristics; ease of disassembly and assembly; marksmanship ability at known distances, semi-automatic and automatic fire; marksmanship ability at unknown distances, semi-automatic and automatic fire; ruggedness and durability; adequacy of safety features; effects of open storage in a tropical environment; ability to penetrate dense brush and heavy foliage; and, the individual Vietnamese soldier's preference between the two weapons.

Analysis [of the Combat Evaluation]

Based on the numerical ratings and the comments of US Advisors and VN Unit Commanders, the AR-15 is the most desirable weapon for use in Vietnam for the following reasons:

1. Ease of training.

2. Suitable physical characteristics.

3. It is easy to maintain.

4. It is more rugged and durable than present weapons.

5. It imposes the least logistical burden.

6. It is the best weapon for all-around tactical employment.

7. Its semi-automatic firing accuracy is comparable to that of the MI rifle, while its automatic firing accuracy is considered superior to that of the Browning Automatic Rifle.

8. Vietnamese troops, Commanders and US Advisors prefer it to any other weapon presently being used in Vietnam.

Details of Comparison Test Between the AR-15 and M2 Carbine

Personnel from a Vietnamese company that had just completed advanced individual training were used as test subjects for most of this comparison. The unit of 180 men was divided into two groups of 90 men each. Group A received one M2 Carbine per man, while Group B received an AR-15 for each man. Each group was then given a course of instruction on their respective weapon. The instruction for each was identical in time and scope of material covered. Following this, both groups underwent an identical test program which consisted of: assembly and disassembly; known distance firing, both semi-automatic and automatic fire; unknown distance firing, semi-automatic and automatic fire; bayonet course; and, infiltration course. This phase lasted for one week (44 hours). At the end of the first week, the two groups traded weapons and the course of instruction and the tests were repeated.

Analysis [of Comparison Test Results]

Test 1 - Physical Characteristics

The AR-15 and the M2 Carbine are comparable in size and weight and both are compatible with the light weight and small stature of the VN soldier. An integral grenade launcher and telescope mount and an accessory bipod are included in the weapon weight of the AR-15. These are not standard items for the M2 Carbine.

Test 2 - Comparative Ease of Disassembly and Assembly

The AR-15 is simpler and requires less time to disassemble and assemble for normal field cleaning.

The average Vietnamese soldier can be trained in the disassembly and assembly for field cleaning of the AR-15 in a shorter time than for the M2 Carbine. This was further emphasized by the fact that all test subjects had previously received 12 hours of instruction on the MI Carbine while undergoing basic combat training.

Test 3 - Marksmanship Ability, Known Distance

The ability of the ARVN soldier to deliver accurate semi-automatic *fire on targets of known range with the AR-15 and the M2 Carbine is comparable. Test participants, as a group, fired a higher percentage of qualifying scores with both the AR-15 and the M2 Carbine than they had previously fired with the MI rifle.*

The ARVN soldier's ability to deliver accurate automatic *fire on targets of known range is far greater with the AR-15 rifle than with the M2 Carbine.*

Test 4 - Marksmanship Ability, Unknown Distance

The ARVN soldier's ability to deliver accurate semi-automatic *fire..using the AR-15 and the M2 Carbine is comparable...the..ability to deliver accurate* automatic *fire..is greater with the AR-15 than with the M2 Carbine.*

Test 5 - Comparative Ruggedness and Durability

After the first week of firing, seven M2 Carbines were eliminated from the test. Six of these would not fire automatically because of defective disconnector springs; the other would not fire at all because of a broken disconnector pin. In contrast, all AR-15s functioned properly throughout the test period.

After negotiating the Bayonet Assault Course the second time, two M2 Carbines were eliminated from the test because of broken stocks. No AR-15 rifles were damaged.

The AR-15 is considered to be more rugged and durable than the M2 Carbine under conditions which require prolonged firing.

The AR-15 will stand up to rough handling normally encountered in combat situations better than the M2 Carbine.

Test 6 - Comparison of the Adequacy of Safety Features

The safety features on the AR-15 and the M2 Carbine are considered comparable with regard to function and the ARVN soldier's ability to understand them.

121. A model 01 Colt AR-15 from circa the ARPA order, serial no. 001627.
Photo credit: Eric Long, Smithsonian Institution

The location of a single selector switch which combines the functions of safety selector and rate of fire selector, on the left side of the receiver where it is easily accessible to the thumb, enables the ARVN soldier to get the first round off faster..than he can with the M2 Carbine. With the M2 Carbine, he must manipulate the safety selector with his trigger finger, then return it to the trigger to fire. With the AR-15 he can keep his finger on the trigger while manipulating the safety selector with his thumb.

Test 7 - Effects of Open Storage in a Tropical Environment

The AR-15 rifle, because it has fewer moving parts, will function more readily than the M2 Carbine after extended periods of storage in the open under tropical conditions.

Test 8 - Brush Penetration

The trajectory of the AR-15 bullet is not significantly affected when fired through dense underbrush at ranges up to 50 meters.

The AR-15 round will penetrate jungle undergrowth equally as well as the M2 Carbine round at ranges up to 50 meters.

Test 9 - Troop Preference Poll

The majority of the test subjects preferred the AR-15 rifle to the M2 Carbine in all respects covered by the poll, except for the sights. Further questioning of the subjects by the test committee personnel disclosed that this preference was due to greater familiarity with Carbine-type sights, not because of an inability to understand the AR-15 sights. This is not considered a shortcoming of the weapon but a matter of training and familiarization.

Conclusions

It is concluded that:

1. The AR-15 rifle is more compatible with the light weight and small stature of the Vietnamese soldier than the M1 rifle, the Browning Automatic Rifle, and the Thompson Sub-Machine Gun.

2. The AR-15 is superior to the M2 Carbine.

3. The M2 Carbine lacks the necessary dependability and versatility for consideration as the basic *shoulder weapon for Vietnamese troops.*

4. The AR-15 is capable of replacing any or all of the shoulder weapons currently being used by the Armed Forces of the Republic of Vietnam.

5. The AR-15 is considered by both Vietnamese Commanders and US Military Advisors who participated in the tests as the best "all around" shoulder weapon in Vietnam.

Recommendations

It is recommended that:

1. The AR-15 be considered for adoption as the basic *weapon for all RNVAF with a view toward improving effectiveness and simplifying training and weapons/logistics systems.*

2. Priority for adoption of the AR-15 be given to those units which frequently operate in jungle environment for extended periods because of the significant operational and logistical advantages accruing to their having the lightest and most effective weapon/ammunition combination available.

3. The M1 and/or M2 Carbine continue to be issued only to those individuals who, because of their duty or position, can function effectively with a weapon best suitable for a defensive role.

The Project AGILE results from the Vietnam field team, excerpted above, were summed up by ARPA back in Washington as follows:

The suitability of the AR-15 as the basic shoulder weapon for the Vietnamese has been established. For the type of conflict now occurring in Vietnam, the weapon was also found by its users and by MAAG advisors to be superior in virtually all respects to the M1 rifle, M1 and M2 Carbines, Thompson Sub-Machine Gun, and Browning Automatic Rifle.

Test data derived from recent Service evaluations of the AR-15 in the US support the technical conclusions of the report. The Central Intelligence Agency has conducted similar tests; it is understood that the results of that evalua.tion are essentially identical to those contained in the [above] report...

Down and Dirty - Lethality in Vietnam

In the aftermath of Project AGILE's combat trials came frank remarks, from American advisors and Vietnamese commanders alike, in response to questions concerning the terminal effects of .223 cartridges they had witnessed fired against the Viet Cong.

Some of these comments are reprinted below, beginning with the ARPA field team's introduction:

..Unit Commanders' and Advisors' remarks concerning the value of the AR-15 in Vietnamese units and its worth as a combat weapon in the war in South Vietnam as opposed to existing weapons were also requested.

Generally, the comments were extremely favorable to the AR-15. All of the comments received are presented below..in the form in which they were received.

"On 160900 June..one platoon from the 340 [ARVN] Ranger Company was on an operation..and contacted 3 armed VC in heavily forested jungle. Two VC had carbines, grenades, mines, and one had a SMG. At a distance of approximately 15 meters, one Ranger fired an AR-15 full automatic hitting one VC with 3 rounds with the first burst. One round in the head took it completely off. Another in the right arm, took it completely off, too. One round hit him in the right side, causing a hole about 5 inches in diameter. It cannot be determined which round killed the VC but it can be assumed that any one of the three would have caused death. The other 2 VC ran, leaving the dead VC with 1 carbine, 1 grenade and 2 mines." (Rangers)

"On 9 June a Ranger Platoon from the 40th Infantry Regt. was given the mission of ambushing an estimated VC Company. The details are as follows:

a. Number of VC killed: 5
b. Number of AR-15s employed: 5
c. Type of engagement: 30-100 meters
d. Type of wounds:

1. Back wound, which caused the thoracic cavity to explode.
2. Stomach wound, which caused the abdominal cavity to explode.
3. Buttock wound, which destroyed all tissue of both buttocks.
4. Chest wound from right to left; destroyed the thoracic cavity.
5. Heel wound; the projectile entered the bottom of the right foot causing the leg to split from the foot to the hip.

These deaths were inflicted by the AR-15 and all were instantaneous except the buttock wound. He lived approximately five minutes."

"..Five VC were hit, all five were body wounds, and all five killed. Four were probably killing wounds with any weapon listed, but the fifth was essentially a flesh wound. The AR-15 made it a fatal wound...The troopers have a great deal of respect for the weapon and prefer it to all others. They take excellent care of it."

On 23-24 May..one company completely equipped with AR-15s (87) plus Bn. HQ elements was involved in..action. No wounded were captured and all casualties were inflicted with the AR-15. 27 VC were killed (24 counted by the advisor) and 25 captured. Grenades were used for the first time and were very effectively employed at ranges of 100-500 meters. They served as the real artillery support as we could not get the artillery to fire any closer than 400 meters. About 36 grenades were utilized in the heavy action, all propelled from the AR-15. The troops are very enthusiastic about the weapon and treat it with greater care than usual."

(7th Infantry Division)

On 13 April, a Special Forces team made a raid on a small village. In the raid, seven VC were killed. Two were killed by AR-15 fire. Range was 50 meters. One man was hit in the head; it looked like it exploded. A second man was hit in the chest, his back was one big hole."

(VN Special Forces)

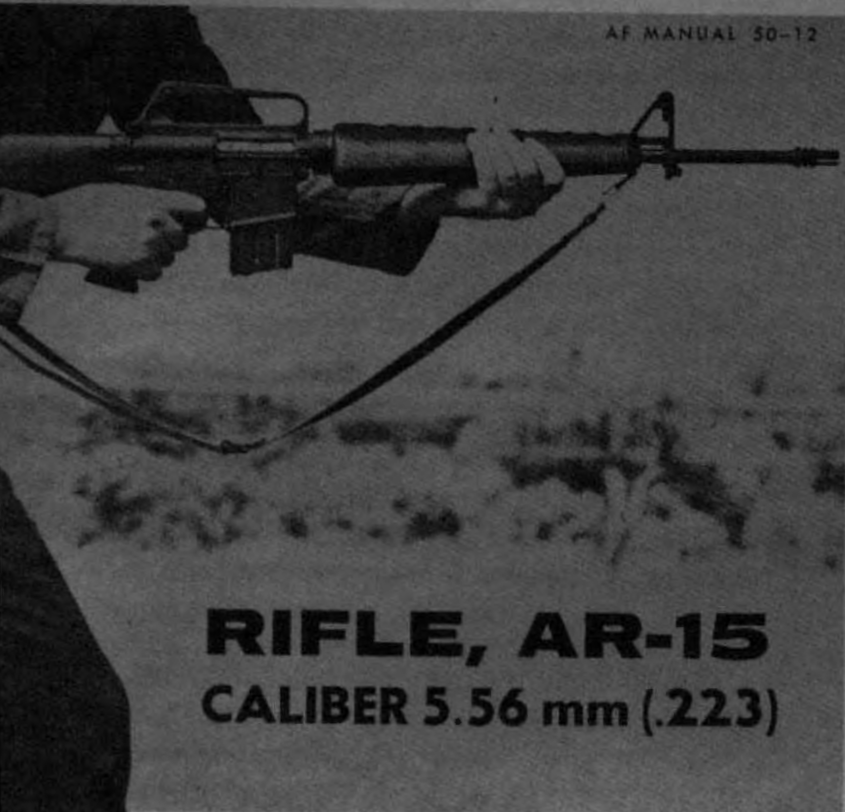
The Air Force Adopts the AR-15 and "Cartridge, 5.64mm (.223)"

As mentioned, the first real breakthrough in quantity production orders for the AR-15 came in the summer of 1962, after nearly three years of slim pickings for Colt's and Cooper-Macdonald. To Dr. Carten's chagrin, the rifles were intended not for small-statured Asian allies but for the US Air Force.

A triumphant General LeMay had seen his third request for AR-15s approved on May 15 1962. Now Chief of Staff of the Air Force, he proceeded to make his own direct contract with the relieved and delighted manufacturers for an initial delivery of 8,500 rifles. As noted in the ARPA report, the AR-15 was thereafter soon officially adopted by the USAF. A second direct procurement of 19,000 more AR-15s was approved for the Air Force the following year.

Also as mentioned, the US Navy soon followed the Air Force lead, ordering a small number of AR-15s to equip its elite amphibious Sea-Air-Land (SEAL) teams. Remington had meanwhile submitted the specifications for the .223 cartridge for registration with the regulatory Sporting Arms and Ammunition Manufacturers' Institute (SAAMI), where the round, now USAF standard issue, was initially identified as "Cartridge, 5.64mm (.223)".

Despite the best efforts of those still loyal to the 7.62mm M14, the AR-15 simply refused to go away. Over the summer of 1962 came a request from the commander of the US advisor group in Vietnam for 20,000 rifles as a head start on the implementation of the recommendations of Project AGILE.



122. The cover of the first Air Force manual for the AR-15, picturing a Colt model 01.

123. Specifications for the AR-15 rifle from USAF manual 50-12. The .223 cartridge is listed as "previously identified as 5.64mm (.223)".

Weight (pounds)

Rifle without accessories	6.31
Empty magazine	.31
Sling	.31
Telescope	.875
Cleaning equipment	.125
Bipod	.56
Bayonet	.625

Length (inches)

Rifle with flash suppressor	39
Rifle with bayonet	44.25
Barrel	20
Barrel with flash suppressor	21

Mechanical Features

Rifling. RH, 6 groove, 1 turn in 12″	
Bore Maximum	.220 in.
Groove Maximum	.2245 in.
Sight radius	19.937 in.
Trigger pull	
Maximum	9.0 lbs.
Minimum	5.0 lbs.
Loading devices	20 round magazine
Method of operation	Gas
Type of mechanism	Rotating bolt
Method of feeding	Magazine—20 rds. cap.
Chamber pressure	52,000 psi max average
Cooling	Air

Ammunition

Caliber	5.56 mm (.223)
Type	Ball and Tracer

Firing Characteristics

Muzzle velocity (approx.)	3250 ft. per sec.
Muzzle energy	1328 foot lbs.
Cyclic rate of fire	700/800 rds. per min.
Maximum rate of fire	
Semiautomatic	45/65 rds. per min.
Automatic (using 20-round magazines)	150/200 rds. per min.
Sustained rate of fire	12/15 rds. per min.
Maximum effective rate of fire	
Semiautomatic	30/40 rds. per min.
Automatic	50/70 rds. per min.
Maximum range	2833 yds.
Maximum effective range	500 yds.

Chapter Six

THE ARMY GETS "A LITTLE BIT PREGNANT"

Also during the summer of 1962, by order of Defense Secretary McNamara the Ordnance Corps as such ceased to exist. Its functions were incorporated, along with those of the other five erstwhile independent Technical Services, into the new Army Materiel Command (USAMC or AMC). Ordnance field functions were reorganized on August 1, first as the US Army Ordnance Weapons Command (OWC), with headquarters at Rock Island Arsenal in Illinois. "Ordnance" was soon dropped, changing the acronym to USAWC; later WECOM. Dr. Fred Carten took up his duties as the Chief of the Technical Branch of the Research Division of AMC's new Research, Development and Engineering Directorate.

By the fall, the M14 procurement program seemed at last to have overcome its serious initial "growing pains". In October a third civilian contractor, Thompson Ramo Wooldridge (TRW), joined Winchester, Harrington & Richardson and Springfield Armory to boost the combined projected M14 production rate to 300,000 rifles per year.

The Hitch Report

Over this same period, as Project AGILE was under way in Vietnam, ARPA staffers back in Washington had introduced the ubiquitous Bobby Macdonald to others in the OSD's Systems Analysis Directorate. A demonstration for all interested OSD personnel was arranged wherein AR-15s and M14s were fired in comparison with the standard assault rifle of the communist world, the 7.62x39mm AK47. Within this framework the AR-15's light weight, low recoil and controllability on automatic fire appeared particularly impressive.

The study indicates that the AR-15 is decidedly superior in many of the factors considered. In none of them is the M14 superior. The report, therefore, concludes that in combat the AR-15 is the superior weapon. Furthermore, the available cost data indicate that it is also a cheaper weapon.

A comprehensive OSD study of the history of service rifle caliber reduction was soon in the works. Starting with the .276 Pedersen round of the nineteen-twenties, OSD analysts worked their way through the ORO studies and BRL's small caliber, high velocity (SCHV) reports of the fifties, and concluded with the results of their own comparison of the .223 caliber AR-15 rifle with the M14 and the AK-47. A report of their findings was sent to Secretary McNamara on September 27, over the signature of OSD's Comptroller, Charles Hitch. Abandoning all pretense that the AR-15 was suitable only for small-statured Vietnamese, the Hitch report stated:

Although analyzed less thoroughly, the M14 also appears somewhat inferior to the M1 rifle of World War 2, and decidedly inferior to the Soviet combat rifle, the AK-47, which, in turn, was derived from the German "Sturmgewehr" of World War 2.

The Controversy Deepens

HQ AMC greeted the Project AGILE results with a grudging admission that the AR-15 did seem a suitable choice for the Vietnamese. Application beyond that, Dr. Carten repeated, would run the risk of seriously upsetting America's NATO standardization agreements concerning the 7.62mm NATO cartridge.

Defense Secretary McNamara, an initial advocate of the M14, was alarmed by the conflicting nature of the reports he was receiving. Both ARPA's Project AGILE and the report from his own Comptroller claimed that the AR-15 was superior to the M14. The controversial Hitch report had gone even further, concluding enthusiastically that the AR-15, the M1,

and even the AK-47 were *all* superior to the M14. Significantly, the Hitch report strongly implied that the "cheaper" .223 caliber AR-15 was a *fully developed* weapon system. McNamara requested the opinion of his Secretary of the Army, Cyrus Vance, on the relative standings of the three arms in question. Pointedly, McNamara asked what actions were contemplated if the Army were to agree with the findings of the Hitch report.

The Army Orders a "Worldwide" Comparison

Privately, it appears that the Chief of Staff of the Army, General Wheeler, shared the opinion of Congress that the Army's function was to use whatever rifles Ordnance (or more lately AWC) supplied. As for replacing the M14, AWC was already on the point of soliciting proposals from industry for the design and manufacture of flechette-and-grenade-firing SPIW weapons, and had just announced the acceleration of the SPIW's planned adoption date to June of 1965, only 30 months away.

Nevertheless, when briefed by OSD on the AR-15 rifle that October, General Wheeler was impressed with the weapon's capabilities. Before drafting his reply to Secretary Vance, therefore, he attempted to get as broadly-based a reaction as possible to the question of the AR-15 versus the M14, from all levels of the Army. He ordered a comprehensive series of *tactical* and *technical* tests of the comparative merits of the AR-15, M14 and AK-47 at bases in the US, the Caribbean, Europe and the Arctic.

President Kennedy had also been briefed on the essential points in the Hitch report, and had asked McNamara much the same pointed questions as McNamara had asked Vance. The upshot was that a deadline was set for General Wheeler's worldwide investigations, which had only just begun, for January 31 1963, a scant three months away.

The Worldwide Trials Part 1 - Tactical

Further restructuring of the Ordnance establishment saw the creation of the Combat Developments Command (CDC), on an equal level with AMC, to handle the "user" or tactical side of weapon acceptance trials. Curiously, the Army Infantry Board, along with its companion "user" unit the Arctic Test Board, had followed Dr. Carten and the OCO, and now took orders from AMC Commanding General Frank Besson. This coupling of erstwhile "user" with "producer" only fueled the fires which followed.

Dr. Carten and his staff drew up and later evaluated the tactical test plan for General Wheeler's worldwide trials. These consisted of seventeen different phases such as known- and unknown-distance automatic fire, penetration, position-disclosing effects, bullet deflections and "psychological suppressive characteristics". However, in an effort to appear impartial, ex-Ordnance officials were by order of the OSD not allowed to attend any of the actual trials. On the other hand, Bobby Macdonald and a Colt field maintenance crew, complete with a fully-equipped mobile workshop, were in close and constant attendance at Fort Benning throughout the trials. As it turned out, they were sorely needed to get any results at all out of some very poorly turned-out rifles and ammunition.

Many regular Infantry soldiers received their first exposure to the lightweight AR-15 as firers and observers in these hastily-conducted Army comparison trials. Unfortunately, the very haste and resultant confusion left precious little time for troop familiarization with what even Dr. Carten himself later called "the overwhelming and irrefutable data" which supported the SCHV concept. Indeed, as a result of routine rotation, the past history of CONARC's championing of the SCHV idea was sadly unknown to most of the present members of the Infantry Board itself. To many, the AR-15 at first glance appeared flimsy and toylike when compared to an issue M14.

In any event, two months into the trials the whole program had degenerated into a loud, bitter stalemate, with the proponents of each rifle accusing the other of bias and outright connivance. The tests themselves broke down completely, less than one month from President Kennedy's deadline. With the final outcome thus in jeopardy, Secretary of the Army Vance was obliged to prudently "cover his assets". Alarmed as he was, he perhaps overreacted somewhat, for by ordering a full scale investigation into the Army's conduct of the trials by the Inspector General of the Army, which he did, the credibility of the whole rifle program was indelibly stained.

124. A Colt AR-15 model 01, pictured during the Tactical phase of the Army's "Worldwide" trials, late in 1962.

The Inspector General's Illuminating View

Through the perspective of the Inspector General's subsequent report on the matter, the story behind some of the innocent-looking statistics the Army was busily gathering do indeed make wry reading. For purposes of our story, however, they are far more than just funny; they reflect the first general confrontation between two fundamentally different schools of thought on what a combat rifle should "look like" and do. In the light of the IG's investigations the vast conceptual gulf between the AR-15 and the M14 stood revealed for the first time.

While investigating Colt's loud accusation that the Fort Benning tests were out-and-out "rigged" in favor of the M14, the IG's team was curtly told by the president of the Infantry Board that "..I have the authority to modify tests in accordance with the circumstances." The circumstances in question revealed not so much deliberate underhandedness as soldiers doing their duty as they saw it. For example, in the absence of any official replacement, the test Boards at both Fort Benning and Fort Greely had adamantly taken as their bible the

Military Characteristics (MCs) for rifles as last published in 1954. Unchanged from the days of the M1 rifle, these still set range requirements at 800 yards. The Board's president concluded that, although the AR-15 had shot well up to 400 meters, "..the average soldier is expected to see and hit at least a bullseye out to a range of 500 meters...I felt we needed to continue with the same rifles out to longer ranges."

The IG investigators also discovered that, not only had the Infantry Board trials thus favored the M14, but on their own initiative the Board had developed a more accurate and controllable bipod-and-compensator-equipped "squad automatic" version called the M14(USAIB), and had even secured permission from the Department of the Army to record the performance of this unofficially improved arm in an appendix to the automatic fire trials results.

The official "user" test group, the newly-formed Combat Developments Command (CDC) headquartered at Fort Carson, Colorado, had deployed "several hundred" AR-15s to all six of its worldwide testing stations. CDC had issued ammunition on a *per round* basis to both M14 and AR-15 test firers, thus in large part negating the AR-15's main inherent advantage of more shots per unit of *weight*. Further, in the face of the fact that most of the M14s in a normal squad were pegged for semi-auto fire only, CDC had ordered rifles *capable* of automatic fire to be *fired* automatically, thus certainly affecting the aimed-fire scores of all the AR-15s.

It will be remembered that in 1959, CDEC's year-long "optimum platoon" trial at Fort Ord had concluded that five to seven men with AR-15s had a better effectiveness ratio than 11 men armed with the M14. On January 19, a memo from Secretary Vance himself ordered that CDEC be taken at their word: "..the CDC test plan [is to] be expanded or modified in a manner which will afford further evaluation of the conclusions reached in the [1959] CDEC report."

Despite all, however, it appeared that the soldiers' strong preference for the M14 in the tactical trials was genuine, and not solely the product of "dirty tricks" or juggling of results. Having been given so little familiarization with the concepts behind the basic SCHV idea, their belief that the heavier 7.62 NATO bullet was superior to the little .223 remained unshakeable. This view was perhaps best summed up in a statement by one of the test officers in response to part of Dr. Carten's "psychological characteristics" test, wherein the officer had been asked to record his feelings regarding "the psychological effect of debris that is deflected by bullet impacts":

> *..with [the M14]..in automatic fire..that hill is just being chewed up, you..see splinters, bits and pieces being thrown around the hill...When you use [the AR-15], being it is a lighter grain bullet, you do not see this effect in the target area. This is a factor...It smacks, I think, on whether..a man would have confidence in his weapon.*

The Worldwide Trials Part 2 - Technical

In further compliance with General Wheeler's order a set of the standard lightweight rifle tests was scheduled, to compare the weapons on a more technical level. These had hastily been initiated, under "crash priority", by the following interesting correspondence:

> *2 November, 1962*
>
> *From: HQ, US Army Test and Evaluation Command*
>
> *To: Commanding Officer*
> *Aberdeen Proving Ground*
>
> *Subject: Comparative Evaluation of AR-15 (ArmaLite) and M14 Rifles*
>
> *Addressees will prepare a summary test plan and estimated funding for phases of the evaluation under their cognizance ...Phases considered as the responsibility of [BRL] will be coordinated with [D&PS]...A final.. plan will be required by 15 November 1962..initiation of testing will not await submittal or approval of final detailed plans.*
>
> *Coordination to define objectives and avoid duplication will be effected verbally and by TWX..since time does not permit letter transmittals.*
>
> *Tests will be completed and reported to this command by 3 December 1962 for review, consolidation, approval and transmittal to [US AMC].*
>
> *Subject evaluation will be performed under crash priority, utilizing overtime where indicated.*
>
> *Representation at tests will be kept to a minimum and will be limited to Army and Government working personnel. Other requests for representation will be..coordinated by this command. Tests should not be influenced or delayed by the requirements for observers. Participating test personnel will not discuss results or express opinions relative to the merits or faults of the subject weapons, but will concern themselves with objective reporting of data..*

7 November, 1962

From: HQ, US Army Test and Evaluation Command

To: Commanding Officer
Aberdeen Proving Ground

Subject: Comparative Evaluation of AR-15 and M14 Rifles

Plans were approved with additions and changes as follows:

(a) Soviet AK-47 is to be included in test effort. Five weapons with 5,000 rounds Soviet (immediately available) and 20,000 rounds Finnish ammunition (to be procured) will be provided this command. Distribution will depend on condition of weapons. Lethality and accuracy (semi and auto) and limited penetration tests will take precedence over other evaluation of this weapon. (Ammunition supply is limited and scope of tests cannot be as extensive as AR-15, M14 comparisons.) The Soviet (Polish) ammunition is slightly different in bullet design than the Finnish and should be emphasized in ballistic evaluation where possible.

Representatives of Colt Firearms and Cooper-Macdonald are encouraged to witness all tests compatible with security clearance..

Other than field stripping, no disassembly of AR-15 weapons used in actual test firings will be permitted without the personal direction of Colt representatives. Phases.. requiring disassembly evaluations will be conducted with spare weapons or on completion of all testing..

Comments on lethality at -65oF are desired..

A lethality determination using a modified .223 bullet will be imposed. The details..will be transmitted verbally..

Funds have been provided to support current testing activity in the amount of $125,850.00..

Aberdeen's Comparative Evaluation of AR-15 and M14 Rifles

Five Colt AR-15s; serial numbers 007036, 008002, 008114, 008367 and 008683; and six M14s were subjected to a battery of seventeen lightweight rifle tests by Aberdeen's Development and Proof Services (D&PS) from November 1 to December 5, 1962. Some of the results and comments made in Mr. George Hendricks' final report are excerpted below:

Weights and Measurements

AR-15 rifle, no. 008367 and M14 rifle, no. 894302 (H&R), were used in this phase. Weights are given in pounds and measurements in inches.

Weights	*Rifle AR-15*	*Rifle M14*
rifle without magazine or sling	*6.35*	*9.32*
empty magazine	*0.29*	*0.52*
one round of ammunition	*a0.0248*	*b0.0541*
magazine capacity (rounds)	*20*	*20*
rifle with fully loaded magazine	*7.13*	*10.93*
rifle with magazine and 120 rounds of ammunition	*9.61*	*16.34*
rifle with 120 rounds loaded in magazines	*11.04*	*18.93*
recoiling parts	*c0.87*	*d0.90*
stock assembly	*0.60*	*3.14*
pistol grip assembly	*0.19*	*-*
handguard assembly	*e0.65*	*0.19*
trigger pull (average for five trials)	*9.27*	*6.19*

a Cartridge, ball, caliber .223, lot Z191.
b Cartridge, ball, caliber 7.62mm NATO, M80, lot FC-1907.
c weight of action spring not included.
d weight of operating rod spring not included.
e weight is for both right and left handguard assemblies.

Measurements	*Rifle AR-15*	*Rifle M14*
overall length (with flash suppressor)	*38.8*	*44.2*
barrel length	*20.0*	*22.0*
sight radius	*a19.8*	*b26.8*
line of sight above bore	*a2.5*	*b1.1*
butt to trigger	*12.9*	*13.2*
pitch (from line of bore), degree	*5*	*4*
line of sight to forward end of comb	*a2.0*	*b2.4*
line of sight to heel of butt	*a2.0*	*b2.7*
barrel: rifling		
one turn in	*14*	*12*
number of grooves	*6*	*4*
firing pin protrusion	*0.029*	*0.057*

a with sight at factory setting.
b with sight set at 200 meters.

..The sighting error when firing the AR-15 rifle is expected to be greater than when firing the M14 rifle because of the shorter distance between front sight and eye. The distance between the sights on the AR-15 rifle is only 74 percent of

125. Fig. 129 from US Rifle M14 *showing the M14 rifle and its range of accessories as produced at Springfield Armory. The Army took the issue of M14 rifle maintenance seriously: note the cutaway buttstock (right center) showing stowage of oil, grease, combination tool, chamber brush and cleaning rod.*
Springfield Armory photo dated August 5, 1961

the distance..on the M14 rifle...It was also observed that the cylindrical front sight of the AR-15 gave a poorer definition when used in direct sunlight than a conventional post..such as that used on the M14..

Automatic Accuracy Test

Rifle	Firing Position	Mean for Shots Fired Automatically(a)	30-shot Target: Mean from Center of Target	EV	EH	ES
AR-15	prone	32.6	21.7	42.7	22.2	44.5
AR-15	standing	56.7	37.9	88.8	42.0	93.2
M14	prone	65.9	43.8	93.0	38.7	98.1
M14	standing	109.4	72.9	164.1	63.7	170.6

a the first shot in each burst is excluded since these are considered semi-automatically fired shots.

..The test data show that the AR-15 and M14 rifles have a low level of effectiveness when fired automatically. The first shot in each burst is fired in the same manner as a semi-automatically-fired shot. In most bursts the first shot was the only shot to hit the 5 ring of the "A" target (12 inches in diameter) and in many bursts, such as when firing the M14 prone with a sling, the first shot in the burst was the only one to hit the scoring rings of the complete "A" target... Firing the M14 rifle automatically from the prone position may cause headache and bruises on the cheek and jaw..

In conclusion, Aberdeen pointed out that direct comparisons between the AR-15 and M14 rifle systems were difficult to make, due to the very different characteristics of the two cartridges used. For example, the weight of the caliber .223 ball round was calculated to be only 46% that of the M80 ball round. Thus, while an empty AR-15 weighed 68% as much as an empty M14, with 120 rounds loaded in magazines it weighed only 58% as much.

Aberdeen did report that the AR-15 rifle had a slightly lower sound pressure level than the M14, both at the firing position and downrange. In addition they commented on the flatter trajectory of the .223 bullet over the M80 ball out to 500 yards. Notwithstanding the fact that 500 yards was the maximum combat range for which the .223 had been designed, the report concluded significantly, "Thereafter the M80 ball bullet has a flatter trajectory."

An Ironic Blow from Within

If the scant time allowance of three months had made difficult the proper design, performance and evaluation of such an ambitious schedule of tests, it transpired that the Army was not alone in feeling the pinch. AR-15 rifles and .223 ammunition for the trials had been ordered on very short notice, apparently soon overtaxing the relatively modest facilities devoted to their respective manufacture at Colt's and Remington. Unfortunately, it appeared that some of the rifles and much of the ammunition had been produced and delivered with little if any effective quality control.

This added a new note of irony, not to say desperation, to the proceedings. In contrast to "old number four", which in Bobby Macdonald's words had performed "flawlessly" during the whole of his initial 8,000-round demonstration trip to the Far East for Fairchild in 1959, the Colt AR-15s which he supplied for the CDC tactical trial in late 1962 were plagued with a malfunction rate eight times that of the M14 control rifles.

To be fair, it appeared that much of the problem lay with the ammuniton. Remington had certified to the Commanding Officer of the Boston Ordnance District that the 428,000 rounds of "Cartridge, Ball, Caliber .223-55 gr M.C." they had supplied for the trials as lot no. RA-5018 complied with a stringent series of specifications and tests. Despite this, there were numerous reports of primers and/or bullets falling out of cartridges during the tests, either leaving the popped primer stuck in one of the locking recesses of the barrel extension to jam the returning bolt, or worse, leaving a spent bullet stuck in the bore. In the rain test at Aberdeen, for example, the test officers reported as follows:

The functioning performance for rifles subjected to the 600-round rain test is given below.

Rifle	*Malfunctions*
AR-15, no. 8002	*Twenty-seven failures to fire, one failure to feed, and five failures to eject. Twenty-five malfunctions were caused by separated primers.*
AR-15, no. 8114	*Seven failures to fire, and one failure to feed. Seven malfunctions were caused by separated primers.*
AR-15, no. 8683	*Thirty-one failures to fire, 11 failures to feed, three failures to eject, and two failures of the bolt to remain to the rear after the last round from the magazine. Twenty-nine malfunctions were caused by separated primers.*

In contrast to these results, four M14 control rifles had also fired the rain test, using standard M80 ball ammunition. Two had completed the test with no malfunctions; one had four; and the last had one. No primer problems were reported.

Thus, what had initially appeared to be such a great (albeit to many a blatantly unfair) advantage soon turned into a real nightmare for the mentioned team of Colt maintenance technicians who had been allowed to attend the trials. Hopping mad with frustration, Bobby Macdonald dashed off furious letters to the management of Colt's and Remington, accusing them of sabotaging his efforts to sell the Army on the AR-15.

The First Nagging Doubts About Lethality

Part of Aberdeen's contribution to the worldwide tests had been the preparation of some special bullets for the Army's Wound Ballistics Laboratory at Edgewood Arsenal. They had modified some 55-grain .223 ball bullets of Remington manufacture by cutting approximately 1/4 inch off the nose and drilling a 3/32-inch-diameter hole about 1/4 inch deep into the lead core of each bullet.

Edgewood's standard lethality trials consisted of measuring the cavitational and other effects of firing at known distances into blocks of ballistic gelatin and, where necessary, anaesthetized goats. They had requested the hollow-pointed .223 bullets from Aberdeen because, while using the standard Remington .223 ammunition which Bobby Macdonald had supplied, they had been unable to duplicate the fantastic, explosive effects which ARPA had documented in Project AGILE.

As it turned out, even the hollow-points failed to duplicate anything like the spectacular effects recorded by the Vietnamese unit commanders and their American advisors, which had subsequently been taken as fact and much used as propaganda in the OSD campaign to sell the AR-15. It was later argued that Edgewood's gelatin formula was not of the proper consistency to replicate human tissue, but in any case such was the magnitude of the controversy surrounding the worldwide trials and the subsequent IG's investigation that at the time Edgewood's report was largely ignored.

The Stone Wall Crumbles

Despite the problems and controversies, General Wheeler's worldwide evaluation was completed by mid-January, 1963. Stubborn initial insistence that "only the M14 is suitable for Army use" had subsequently been thoroughly undermined by the IG's investigation. The Army report finally submitted to Secretary Vance grudgingly concluded that, after firing 500,000 rounds through each weapon, the AR-15 was judged to be superior to the M14 with regard to weight, automatic fire accuracy, and total hit capability. The AR-15's reliability and night-sighting capability were listed as unsatisfactory, however; CDC's Commanding General had even summed up his portion of the tests with the proviso that "I would not standardize the AR-15 rifle without an expedited improvement program to correct the unreliability of the rifle-ammunition combination and the poor night sighting qualities."

Perhaps to avoid the appearance of further bias, the AR-15 was given the benefit of the doubt on the issue of poor functional reliability. Malfunctions encountered with both rifles and cartridges were assumed to be "readily correctible". Results of Secretary Vance's tests of a six-man squad armed with AR-15s versus eleven men with M14s were meanwhile listed as inconclusive. As for the AK-47, the tests had shown it to be "clearly inferior" within US tactical applications to both American weapons.

The M14 still remained the Army's overall choice as a standard semi-automatic rifle, and the M14(USAIB) was recommended for further development as a suitable squad automatic. On the other hand, reliability aside, the CDC and others had confirmed that some units with a special nature and mission were definitely best served by the AR-15.

Secretary Vance's report to the Secretary of Defense therefore took the form of the following historic four-point compromise:

1. Starting in fiscal year 1964 (FY64), the Army proposed the procurement of enough modified M14s like the USAIB model to provide an automatic rifle capability for all infantry squads. (First called the M14E2 and later adopted as the M14A1, this development is discussed in ***US Rifle M14***.)

2. They would also procure between fifty and one hundred thousand selective-fire AR-15s commercially from Colt's, for issue to US Army Air Assault, Airborne and Special Forces units.

3. Production of standard M14s in the existing procurement program would be reduced accordingly.

4. Continuing the SPIW program with a reaffirmed schedule would produce a truly advanced "follow-on" to the M14 by the end of FY65; now only two and a half years away.

Chapter Seven

THE FATEFUL PLAN TO BANK ON THE SPIW

And so, saving as much face as possible under the circumstances, the Army finally capitulated to the combined forces of the OSD, the Inspector General, and Bobby Macdonald. Even though the M14 remained the US Army's semi-automatic rifle of choice, Defense Secretary McNamara decided that the time was opportune to face up to the future as envisaged by his "whiz kid" systems analysts. Their every report said the same thing: a truly advanced follow-on to both the M14 *and* the AR-15 was not only feasible but soon to be a reality.

As discussed in *The SPIW*, projected flechette performance, especially lethality, remains a very touchy subject to this day. Suffice it to say that high theoretical hit probability was a goal right from the start, and was a product of extremely low recoil and high rate of fire. This, coupled with the fearful wounds promised by its tiny flechettes, led to forecasts that once the SPIW came on stream all standard small arms would be rendered obsolete. At the end of 1962, AWC's comprehensive SPIW development program was on track and on time: Standard 'A' hardware was confidently promised in just two and a half years.

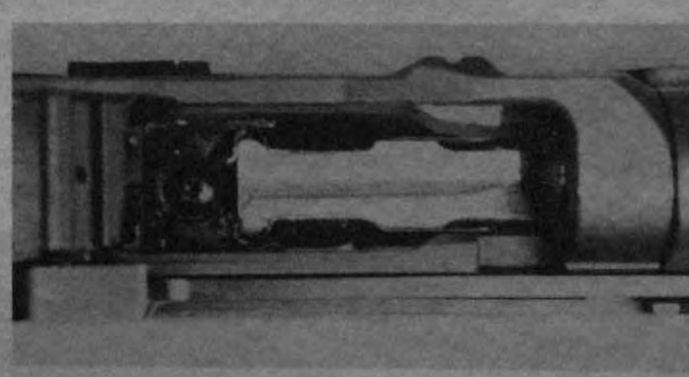
In the interim, McNamara reasoned, why couldn't the Army "make do" with the million or so M14s already in existence? To make the matter even more attractive to a cost-conscious Congress, the balance of the funding already earmarked for future M14 rifles could then be applied to acquiring the AR-15s which the Army now wanted for its Air Assault, Airmobile and Special Forces units. With the SPIW a seeming certainty, it appeared both wasteful and unnecessary to procure more AR-15s *or* M14s than absolutely necessary to bridge such a brief span of time.

Secretary of the Army Cyrus Vance summed up the Army's position before a curious Senate subcommittee with the fateful remark: "Termination of production of the M14 prior to the availability of SPIW involved certain risks which, after consideration by the Army, are deemed acceptable."

Accordingly, on January 21, 1963, Secretary McNamara announced the cancellation of the M14 production program.

126. In a desperate attempt to salvage what they might from the abruptly cancelled M14 program, TRW attempted this conversion of an M14 to .223 caliber. *Neal Smith collection*

The contracts then in place were allowed to continue only until the autumn, notwithstanding that total production of the M14 rifle would thus fall far short of the Army's full requirement. In consequence of this surprise move, all three civilian M14 producers, H&R, Olin (Winchester) and TRW, found themselves stuck deeply in the troughs of their respective "learning curves", with any hope of further recouping their initial investment abruptly cut off. Contracts for two of the four first-generation SPIW prototypes were coincidentally and simultaneously awarded to H&R and Winchester, but the loss of the M14 program was nevertheless a very heavy blow to all concerned.



127. Top view of the TRW .223 caliber M14, showing attachment of filler block and modified magazine follower.

128. Closeup of the action, right side, of the TRW .223 M14 conversion. Note the filler block and modified magazine catch, behind the (painted) AR-15 magazine.

The Army Initiates its Famous "One-Time Buy" of AR-15s

At the same time as the cancellation of the M14 program, negotiations were begun with Colt's to supply the Army with 85,000 AR-15s over the following three fiscal years. According to Secretary McNamara'a timetable, by that time the successful SPIW candidate would have already been perfected, adopted and put into production: the 85,000 AR-15s were all the Army would ever need.

In order to allow an orderly expansion of manufacturing facilities at the Colt plant, the initial "trickle" delivery was to be set at just slightly over 2,000 rifles for FY64, after which it was planned that production should be able to meet demands of up to 50,000 AR-15s per year.

As noted, AR-15 rifles and .223 ammunition had hitherto been purchased "off the shelf" directly from the manufacturers by whichever service or agency had managed to get its purchase request approved. Thus far there had been no central purchasing or regulating authority within the military. As with numerous other limited-issue items, such as revolvers and shotguns, the military had virtually no control over, or funded interest in, the specifications of either the AR-15 rifle or its cartridge. However, on March 11, 1963, soon after approving the Army's one-time purchase of AR-15s, McNamara in a secret memo to Army Secretary Vance directed that the four services get together to draft a set of military specifications for the AR-15 rifle and the .223 cartridge, with the number and cost of any improvements or modifications to be kept as low as possible.

The AR-15 Gets a Project Manager

The Army had already installed a new system of direct management for projects needing special attention, such as the M14 rifle. The following are excerpts from a March 4th explanatory memo issued by the Commanding General of Army Materiel Command, outlining the reasons behind Project Management and the special powers that went with the job:

129. "For immediate release": a proud publicity photo from Colt's parent firm, Fairbanks Whitney Corporation, labelled "Colt's Oldest - and Newest - US Combat Rifles" heralds the Army's announcement of the "one-time buy" of AR-15 rifles.

Left: a custodian of the Colt museum at the Connecticut State Library in Hartford holds a 5-shot, .56 caliber revolving musket which Samuel Colt produced for the US government during the Civil War.
Right: a Colt's assembly employee holds a brand-new, selective fire Colt AR-15.

Project Management has been endorsed by the Secretary of Defense as a means of reducing materiel lead time. It has been applied within my command to critical weapons and items of equipment that collectively account for over half of the total AMC PEMA and RTD&E funds. The corresponding magnitude of responsibilities assigned to Project Managers, the radical departure of this new concept from the Army's traditional way of managing its materiel, and the compressed time period during which it has been introduced have resulted in a new set of management problems.

..I have delegated to each Project Manager my full line authority to make decisions regarding his particular weapon and/or items of equipment. In exercising my authority, I expect that a Project Manager will..deal on a direct basis with all contributing elements of AMC, serving as a master project planner and providing both the direction and control necessary to implement such plans; [also] deal direct with the OSD, DA staff, CDC, CONARC, field units of the Army and the other military services [and] act with the complete assurance that for all activities required to manage and direct his weapon/item system he is acting for me alone and is in no way responsible to any functional directorate;

..The Project Manager will initiate the project plan, the annual program and budget request, reprogramming actions and other..changes..as are necessary to satisfy requirements that have been set by the Army for its..materiel...Primarily, responsibility for the direction and control of major contractors rests with the Project Manager. In the past, contractors have, on occasion, received different and conflicting instructions from several sources within the Army; henceforth,

contractors will look only to the Project Manager..for their instructions.

I am convinced that the system of vertical management we have installed will be of great and lasting benefit to the accomplishment of our mission. Each Project Manager will be personally considered and approved by me before any indication of his possible selection is made. It is my intention to obtain for these positions the highest caliber and most fully qualified officers that the Army can provide - the leaders of tomorrow who are preparing that base today.

[signed,]
F.S. Besson, Jr.,
Lieutenant General, USA
Commanding

The "Office of Project Manager for AR-15 Rifle Activities" was established on March 6 with headquarters at Rock Island Arsenal, Illinois. After due deliberation, General Besson appointed Lt. Col. Harold T. Yount as Project Manager, a capable officer and the son of old family friends. Bill Davis, still the Superintendent of the NATO North American Regional Test Center for ammunition, introduces this pivotal character in our story as follows:

I first met Harold Yount when he was assigned to the Small Arms Branch, [D&PS], at Aberdeen..in the mid-fifties...I believe that he was then a captain of Ordnance, soon to become major. He had a strong avocational interest in small arms (as did many of us then in that organization), had been a "Golden Bullet" rifleman in interscholastic marksmanship competition during his college days, and was still active in competitive shooting. He was assigned to Aberdeen as a Proof Officer, directly engaged in the day-to-day testing of small arms and ammunition, which was the business of that organization. He was bright, industrious, highly motivated, eager to learn, and professionally competent.

As noted by General Besson, Lt. Col. Yount's "Office of the AR-15 Project Manager" was established to achieve the earliest possible acquisition and deployment of the AR-15 system, as directed by Defense Secretary McNamara. Among the Project Manager's many duties and responsibilities was the coordination of "product requests" from all the other services and agencies who had hitherto made their own deals direct with Colt's and Remington. Another duty, even more important from the standpoint of our story, was the preparation each week of a management report, informing HQ AMC of the significant happenings within the program during the past week. Fortunately, a complete set of these reports survive.

130. A rare, early Colt model 01 instructional cutaway AR-15. This arm features the Colt "green stock", which was simply the old brown stock painted green.

Lt. Col. Yount certainly came to his new powers with a clean slate, admitting as he later did before the Ichord subcommittee that he had never set eyes upon an AR-15 prior to being selected as that program's Project Manager in March of 1963.

The Formation of The Technical Coordinating Committee (TCC)

The following excerpts from the first few AR-15 Project Manager's Weekly Reports allow us to pick up the initial threads of the adventures to which Harold Yount was so speedily introduced:

AR-15 Rifle: Initial submission

..The Project Manager visited Springfield Armory on 13 March to coordinate project activities. Springfield..engineering facilities are currently evaluating correction of deficiencies as reported by [BRL] and other test results. Efforts are being directed in the areas of bolt closure, magazine assembly, grenade attachment, and muzzle compensator/flash hider.

On 14 March, together with representatives of Springfield Armory, Boston Procurement District, Remington Arms Co., and USAMUCOM [the Army Munitions Command at Frankford Arsenal], [we] visited the Colt Patent Fire Arms Mfg. Co., Hartford, Conn. Colt's engineering staff is currently working in several design areas of the rifle. The Colt firm has furnished engineering design data for the rifle to [MUCOM]. Engineering design data for ammunition has also been furnished by Remington Arms Co...The above engineering data is necessary to study and resolve the present design dimensional incompatibility of the ammo-gun system.

AR-15 Rifle: [week of] 18-22 March 1963

A meeting was held at [HQ, AWC] on 21 March with Mr. David Scott, President, Colt's Patent Fire Arms Mfg. Co., Inc., and Mr. Kendall Barnes, General Counsel, [AMC]. The purpose of the meeting was to discuss patent rights and licensing agreements in association with the AR-15 program. No definite conclusions were reached at the meeting, however, a new approach to the subject will be discussed with Colt's.. during the week of 25 March.

AR-15 Rifle: [week of] 25-29 March 1963

A series of briefings, starting with USAMC Commanding Staff and proceeding through R&D, DCSLOG [the Army's Deputy Chief of Staff for Logistics] and the Chief of Staff, General Wheeler, were presented concerning the recommended procurement program for the AR-15 rifle. Technical changes to the rifle and relating ammunition program requirements were widely discussed. The recommended procurement plan was approved in principle, however, certain deficiencies are to be resolved regarding quantities of rifles and relating ammunition to be procured.

A joint Technical Coordination meeting was held at Eglin Air Force Base among representatives from the Air Force, Army and Industry to exchange views on the technical status of the AR-15 rifle. Mr. Stoner, the AR-15 rifle designer, participated in the meeting. This was the first of such joint meetings planned.

AR-15 Rifle: [week of] 8-12 April 1963

TECHNICAL COMMITTEE: A Technical Committee, to be comprised of Army, Navy, Marine and Air Force representatives is being established to technically coordinate and decide on matters pertaining to the achievement of a single standard AR-15 rifle. [The] AR-15 Rifle Project Manager will chair the committee..

A contract was signed with Remington Arms, Inc., Bridgeport, Connecticut, on 11 April for 600,000 rounds of Cal. .223 Ball ammunition to support the AR-15 Rifle evaluation program.

[signed],

Harold W. Yount

Lt Colonel, OrdCorps

AR-15 Project Manager

Chapter Eight

THE FIRST 130 CHANGES TO THE AR-15

Ominous Overlords

And so, under orders from the Secretary of Defense, the Army moved to establish the centralized "one-time buy" of AR-15s for all the services. Nominal control of the whole procurement package was vested in Lt. Col. Yount, the AR-15 Program Manager and Chairman of the TCC. Significantly, however, veto power over the TCC's decisions was retained by Defense Secretary McNamara, who also declined General Besson's proposed "arm's length" OSD liason with the TCC through a "Project Manager Staff Officer" (PMSO) stationed in Washington. To ensure direct OSD participation in the TCC, Secretary McNamara appointed both his Deputy Assistant Secretary in charge of Weapons Acquisition and Industrial Readiness, and a program analyst from the OSD's Directorate of Major Items, Materiel, Installations and Logistics, as members.

Bill Davis, soon to be drawn abruptly into the thick of the fray, further explains the behind-the-scenes setup of the TCC:

After the formation of the famous Technical Coordination Committee (TCC), the technical decisions..were ostensibly to be made according to some sort of consensus of the Army, Air Force and Marines...The distinction between the fiction and the facts about the decision-making process in the TCC is perhaps one of the greatest ironies in the history of the M16.

..while McNamara had charged the TCC with the responsibility for making the technical decisions concerning the AR-15/M16, he stipulated that the authority to veto *those decisions was reserved to OSD...it was made quite clear to the Project Manager that OSD had final authority over the proceedings of the TCC, although Col. Yount, like a good soldier, never explicitly said so.*

..a representative of OSD sat..at the meetings of the TCC ...[He] was from the office of the OSD Comptroller, the same office that had prepared the Hitch report, and he made it quite clear that he represented OSD. The whiz kids who had directed the technical odyssey of the AR-15 rifle/ammunition system before McNamara's decision to assign procurement authority to the Army were still effectively in charge, by virtue of their delegated veto power, thus retaining their fiercely guarded authority, *while neatly unencumbered by any concomitant* responsibility...

Establishing a Caliber .223 Ammunition Base at Frankford Arsenal

As mentioned, the AR-15 rifle and the .223 Remington cartridge were hitherto procured "off the shelf" with little military involvement in the setting and checking of standards and specifications. The TCC therefore quite naturally wanted a firm "handle" on just exactly what had been purchased up to date, to assist them in defining the parameters of the future rifle and cartridge in military terms.

..This situation ended abruptly in March of 1963, when.. Frankford Arsenal was assigned the task of overseeing procurement of [.223] ammuniton.

Bill Davis' "comfortably detached" position as Superintendent of the NATO North American Regional Test Center was soon just a memory:

This was not an enviable position...Frankford Arsenal.. had not previously been involved with the .223 ammunition in any way...I was excused temporarily from most of my

other duties, given the ad hoc *title of "AR-15 Project Director" for the commanding officer, and directed by him to set about the unenviable task of preparing a technical data package for ammunition procurement which would satisfy the requirements of the various users.*

..The urgency which characterized early stages of the program did not allow time for preparation of formal technical reports, and so the documentation..took the form of informal Memo Reports, each addressing one particular aspect of the task. Ten such reports were published within the first year of this engineering effort, during which some essential product improvements were effected..

As an example of the scope and value of these Frankford reports, Mr. Davis' Second Memo Report on the AR-15 Rifle/Ammunition System of 17 June 1963 entitled *Investigation of Test-Weapon Chamber Configuration*, analyzed the design data which the manufacturers had furnished. This report confirmed discrepancies between some of Colt's tolerances for the rifle's chamber, and Remington's specifications for the ammunition. Modifications to correct these "design dimensional incompatabilities" were taken under consideration by the TCC, as were a number of other minor improvements suggested for heat treatment or finish on various parts of the rifle.

Few of the other proposed weapon or ammunition changes were so smoothly processed. For various reasons neither the Army nor the Air Force could resist the opportunity to make their own mark or stamp on the new rifle. Thus, shortly after Lt. Col. Yount's progress report of March 28 had noted that changes were being "widely discussed", Secretary McNamara was aghast to learn that the TCC had tabled over 130 proposed changes to the rifle/ammunition package. Many were minor and technical in nature, like those mentioned above, but three main issues soon emerged. On two of these the Army and Air Force made their respective stands against the power of the Secretary of Defense and, where necessary, each other. Neither would budge, thus holding up the contract award to Colt's for the rest of the year.

The Deja Vu From the Top

Secretary McNamara's 1963 decision to accept the AR-15, albeit only as a stopgap on the way to the SPIW, proclaimed final, official recognition of the SCHV concept. (The fact that five years of M14 production had intervened, five fallow years as regards AR-15 engineering development, was not his fault.) Unfortunately, in an ironic reversal of Dr. Carten's fatally mistaken *denial* of the AR-15's merits in 1958, the Defense Department's "coterie of cerebral academics" tended to fulsome overstatement: it was as if Gene Stoner's "creations" had sprung, perfected, from the well of genius itself. In this heady atmosphere, pseudoscience reigned: the gruesome lethality results of Project AGILE; the Hitch report's enthusiastic inference that the AR-15 was a fully-developed weapon system; and Colt's claim that the AR-15 would fire longer without cleaning than any other rifle; were all eagerly accepted at face value. McNamara therefore viewed the acquisition of the AR-15 rifle and ammunition system as a relatively simple process: to him, the investigations commissioned in good faith by the TCC, particularly the Frankford Arsenal ammunition studies, threatened to involve the program in a seemingly infinite "universe" of arcane technical considerations. On June 27, McNamara ordered the TCC to "keep it simple":

To capitalize on the potential of this weapon for the special units and to assist in determining the follow-on system to the M14, the AR-15 should be procured and placed in the hands of troops at the earliest date. This is to be accomplished with the least administrative lead time, and at the lowest cost for a sound product, and at the most rapid delivery date.

This McNamara memorandum also confirmed that all proposed modifications to the unified rifle were to be first agreed upon by all four services, then submitted for OSD approval before formal announcement by the TCC.

As we shall see, it was a time when the best possible counsel would have been none too good to ensure an optimum course for the AR-15, yet basic specifications which were to affect all future production were irrevocably set, at OSD insistence, without a firm appreciation of all the facts. The consequences of some of the early decisions, involving seemingly miniscule but unfortunately ill-understood tradeoffs, are examined below.

Dr. Carten later commented wryly on one aspect of Secretary McNamara's personal interest in the AR-15 program. As it turned out, he was describing the hapless TCC:

..The overall result of such high level continuous interest is that the technicians spend more time on the quality of their presentations and briefings than they do on technical matters and projects suffer accordingly. There is also a tendency for the average technician to agree with higher authority since disagreement exposes him to the intensive, and many times unflattering, scrutiny of the top echelons.

Formalizing the Fiction - The Gilpatrick Directive

The Project Manager's plight was thus unenviable in the extreme: he was forced to come to grips with what was really an exceedingly complex technical situation, under strict and unrealistic parameters set by the Defense Department. Credit for the TCC's successes would ultimately be taken elsewhere, but, "like a good soldier", Lt. Col. Yount was a sitting duck in the event of failure.

An example of the illusory nature of the TCC's powers and freedoms came on July 26, with the flow of crucial technical data on cartridge parameters from Frankford just hitting its stride. McNamara's Deputy Secretary of Defense, Roswell Gilpatrick, advised the TCC of even tighter controls in an effort to hasten and simplify the "one-time buy":

> *I believe it to be essential that we avoid the cost, delay and management difficulties of the quality assurance, parts interchangeability, and acceptance test standards programs of previous rifle procurement. Special attention will be given to ensure that the goals established in these technical packages are realistic from a cost and production viewpoint, do not exceed practical user requirements, and are developed early with the manufacturer to avoid conflict between production inspection standards and acceptance inspection standards. A deliberate effort should be made to limit interchangeability requirements to those parts which can be realistically changed in the field.*

This unprecedented OSD involvement in a rifle procurement program, hitherto the prerogative of the Army itself, was for many an unwelcome affront, and did little within that community to enhance the popularity of the AR-15. On the other hand, the Air Force, Navy and Marines, whose opinions had seldom been sought when Army Ordnance officials had been in charge of all small arms testing and procurement, were now able and determined to present their own views.

The Great Rifling Twist Controversy

In the early course of the AR-15/M16 program a number of great claims were made within OSD concerning the novelty and genius of Stoner's original designs. Indeed, much of the later criticism that was heaped upon the Army, and in particular the Project Manager, was for wantonly or perfidiously tampering with the "already perfected" AR-15 and/or its ammunition. In the course of this book we will examine the validity of a number of these issues in detail.

One such was a lengthy dispute over rifling twist. The crux of this debate concerned the alleged enhancement of bullet lethality imparted by the "marginal gyroscopic stability" inherent in the AR-15's original rifling specification of one turn in 14 inches. Bill Davis, by this time as noted the AR-15 Project Manager for .223 ammunition at Frankford Arsenal and one of America's foremost ballistic engineers, fills in some interesting background to the barrel twist debate:

> *..I must hasten to add that these specific claims have not been by Stoner himself, so far as I know, but were made by his enthusiastic disciples in OSD, and were popularly accepted by the media and by many self-styled experts who have written about this matter.*
>
> *..As for the 14-inch twist, one theory holds that it was carefully chosen, so as to impart to the carefully designed bullet, exactly the correct degree of gyroscopic stability to maximize its lethality. On the other hand, it was hardly without precedent. Rifles being built by Remington for the .222 Remington commercial cartridge had 14-inch twist of rifling, as indeed did nearly all other "varmint" rifles firing .22 caliber bullets of about 50 to 55 grains weight. The gyroscopic stability of 55-grain "varmint" bullets was quite satisfactory in the 14-inch twist, and at first thought it might be supposed that the 14-inch twist would impart the same degree of stability to a 55-grain military bullet as well. To perceive that this is not the case requires an understanding of the role played by the ratio of axial to transverse moments of inertia in a bullet, and the effect of a longer ogive and a boattail on this critical ratio... In any event, the 14-inch twist failed to provide sufficient spin for adequate gyroscopic stability of either Stoner's original bullet, or the M193 bullet designed by Remington.*

The Air Force Blows the Whistle

While by all accounts the AR-15 performed well in the jungle, many USAF Strategic Air Command bases were situated in decidedly less temperate parts of the world. In January 1963, the USAF had released a report entitled *Exterior Ballistics of the AR-15 Rifle*, which described firing tests they had conducted in a climactic hangar cold chamber at Eglin AFB. These confirmed earlier BRL reports that, in 1-in-14 barrels, Stoner's professedly marginal bullet stability quite literally wobbled over the edge of accuracy acceptability, due simply to the increased density of air at subzero temperatures. Barrels with a twist of only one turn in twelve inches had solved what the Air Force saw as essentially a cold-weather accuracy problem affecting the worldwide acceptability of the AR-15. Through the TCC, they accordingly recommended that the 1-in-12 twist be adopted as standard in the new procurement, concluding that "changing the twist in the barrel does not reduce the lethality of the bullet".

Bullet lethality is of course a tradeoff. Even at normal ambient temperatures the marginal gyroscopic stability imparted by a 14-inch rifling twist had a detrimental effect on the accuracy of .223 caliber military bullets. Statistically, therefore, the slight increase in probability that a hit from a 14-inch twist barrel would kill (PhK) was more than offset by the increase in probability of getting a hit in the first place (Ph) with a more stable, and hence more accurate, bullet from a 12-inch-twist barrel.

The Army's worldwide trials had reported reliability problems, but generally those AR-15s had been stretched well past their designed range limitations before serious accuracy degradation had shown up. The Army therefore challenged the rifling change, until further tests of their own corroborated Air Force results. They then withdrew their objection, and Secretary McNamara personally approved the change to 1-in-12 rifling on July 26. The following month, the TCC formally adopted the 12-inch twist modification "without controversy", although as we shall see the issue was not yet finally laid to rest.

The Army's Bolt Closure Device

One thing the Army had held on to since the days of the '03 Springfield was a positive way for the soldier to close the bolt of his rifle, should the need arise. The M1 had this feature, as did the Carbine and the M14. One of the main US Ordnance criticisms of the FN FAL back in the fifties was that it had no such provision. In any case, the Army would not back down on the need for a manual bolt closure on the AR-15, and stated its case with eloquence and determination in this official "position paper":

..The AR-15 is to be issued to Combat Infantrymen who are expected to use the weapon under the worst possible conditions of dust, dirt, mud, and foreign matter affecting both weapon and cartridges. If the mechanical spring fails to close the bolt the soldier must have the capability of immediately correcting the situation without disassembling the rifle...Any chance, no matter how slight, of malfunction in combat due to the inability to manually close the bolt is unacceptable..

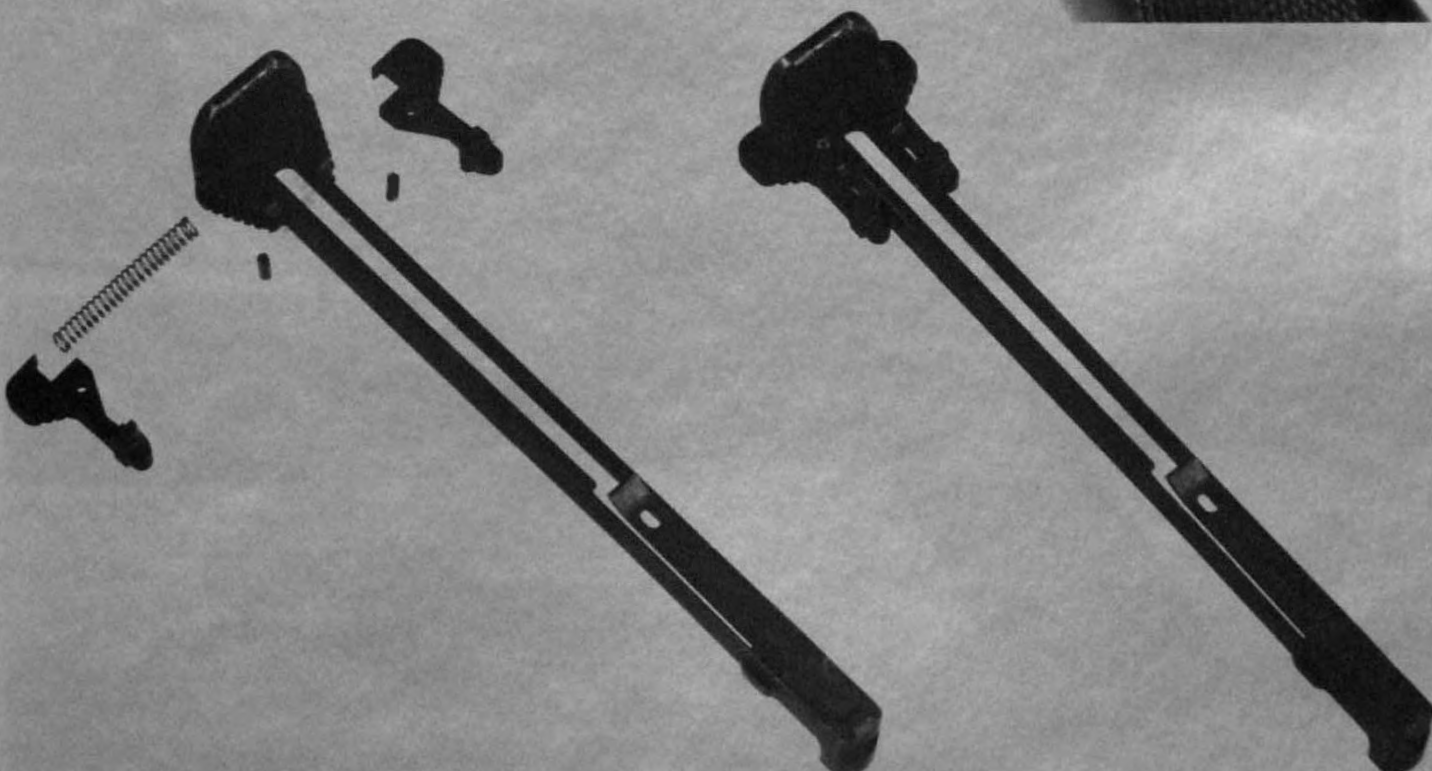
The frequency or infrequency of the type of malfunction correctable by a manual bolt closure capability is immaterial. The knowledge among troops that such a malfunction is merely possible would lower confidence in a weapon lacking [such] a..device.

The ability to close the bolt manually on any semi-automatic rifle is considered necessary as an emergency measure. Neither the M1 or the M14 Field Manual recommends forcible closure of the bolt under normal conditions. However, FM 23-5 (US Rifle Caliber .30 M1) states..that in loading a full clip, "you may strike forward on the operating handle with the heel of the right hand when necessary to fully close and lock the bolt."

An important side benefit..would be the ability..to silently chamber a round. This is impossible if the bolt must always be slammed home under pressure of the operating spring.

Gene Stoner had initially been given somewhat guru-like status as an unofficial member of the TCC. At first glance this was a unique and enviable position but, as he later related, being this close to the OSD-dominated TCC was in reality rather frustrating. As regards the bolt closure idea, for example, Stoner later told the Ichord subcommittee:

131. Closeup of a "green stock" Colt model 01, serial no. 011476, featuring one of two Springfield Armory versions of a bolt closure device. To close the bolt, the user pushed in the rear projection with the heel of his hand.



132. "Bolt Closure Device #1 with Dual Latches" - exploded and isometric views. A slot in the top of the receiver was fitted with an angled cam block (fig. 131) which pushed the flat spring (above) down into contact with the (modified) bolt carrier. This was the device, if any, that Gene Stoner recommended.

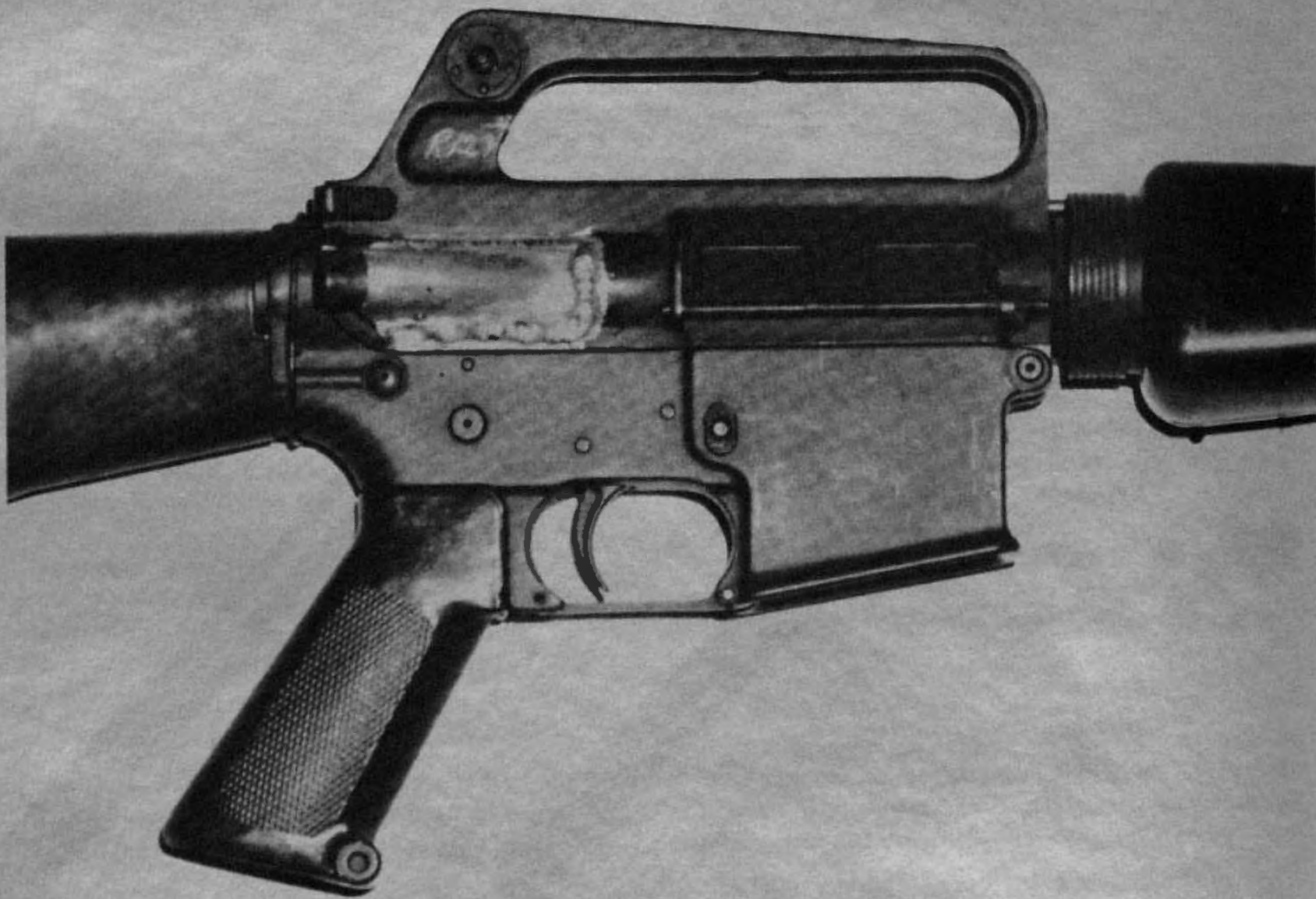
Springfield Armory photo dated October 14, 1963

133. Another "green stock" Colt AR-15 model 01, serial no. 011767, experimentally fitted with a left-handed version of Colt's second bolt closure design. The Air Force objected strongly to the whole idea of a bolt closure device, while the Army just as adamantly insisted on it.

..in this bolt closure device that the Army insisted putting on, I was asked by Colt and some people in the Army my opinions on this thing and what it would do to the weapon. There was a lot of thrashing around to come up with a system that would satisfy the Army and also be compatible with the weapon. The [Springfield Armory] one I..thought would be the least harmful was the one they did not adopt. They turned around and put this other [Colt] one on.

Stoner went on to say that he had picked the Springfield Armory design because it required less alteration to the rifle, and was the easiest to do away with when the Army finally decided it wasn't worth putting on in the first place. When asked if he believed the closure device did any actual harm, Stoner continued:

..Well, in my opinion, in all the development - and I tested this weapon..in India and Europe and all over the United States; I was on many testing programs - I never saw an



134. AR-15 model 01, serial no. 013168, with "in-the-white" experimental model of Colt's right-handed thumb-closer idea.
Rock Island Arsenal collection, photo by Richard S. Smith

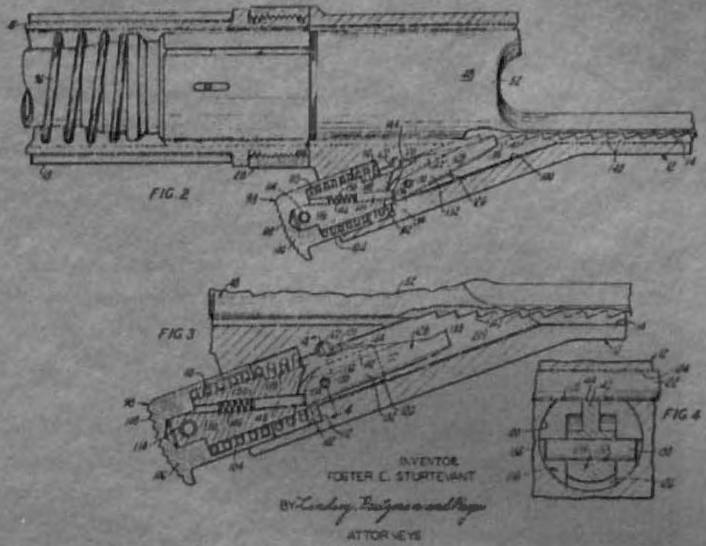
instance where it would have done any good…under sand and mud and every type of firing conditions in the world. I was always afraid of [a bolt closure device] myself, because when you get a cartridge that won't seat in a rifle and you deliberately drive it in [to the chamber], usually you are buying yourself more trouble. The thing that I always thought of was immediate action. To get that [cartridge] out of there and find out what the trouble was; rather than jam it in and fire it.

Bill Davis concurred, offering more insight into why the Army would choose to "make its stand" on such a relatively minor and indefensible issue as the bolt closure device:

..There are a few circumstances in which a bolt forward-assist device might be useful, to a well trained rifleman who is able to analyze the situation and use the device judiciously. Not all troops are very well trained in such matters, however, and the injudicious use of the forward-assist..is less likely to clear a stoppage by immediate action than to turn an easily clearable stoppage into a virtually unclearable one.

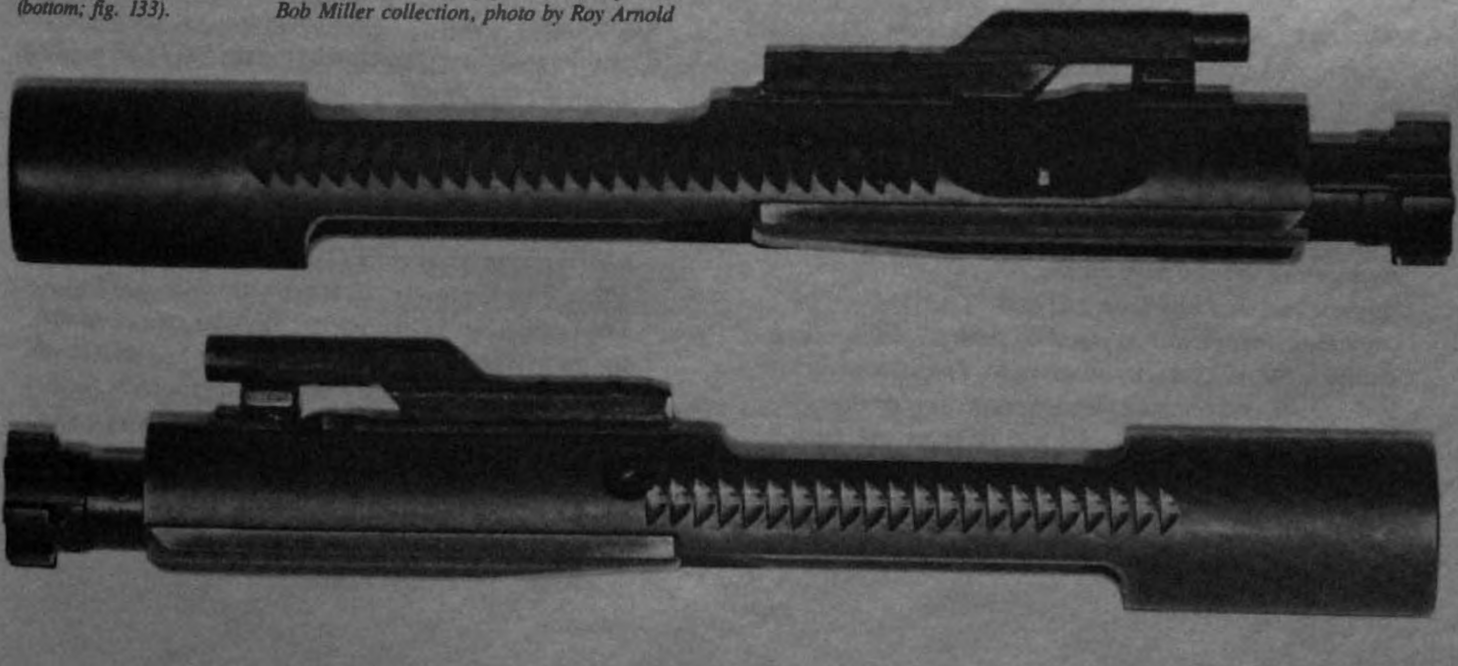
It is my personal opinion that the stubborn stand taken on this issue by the Army..was provoked by the frustration that they felt at the impotence to which the TCC had been reduced by the much-used veto power of OSD, on every issue, great and small. It was unfortunately a weak issue on which to take such a symbolic stand..

Unhappily, the spirit of harmony which had seen all the services concur on the Air Force's 1-in-12 barrel twist did not extend to the Army's case for the bolt closure device. In fact the Air Force, the only service to have already adopted the AR-15, was understandably dead against the idea, stating in part in



135. Figs. 2, 3 and 4 from US Patent 3,326,155, granted to F. E. Sturtevant and assigned to Colt's, entitled "Firearm Having an Auxiliary Bolt Closure Mechanism". As can be seen, the Air Force was right about the "weight, cost and complexity" of the device, the action of which is briefly described from the four-page, 15-claim patent as follows: "The mechanism 98 is slideably received within the generally cylindrical side passage 100 of the receiver 12…As best seen in figs. 3 and 4, the plunger 116 is generally cylindrical and possesses a longitudinal recess 118 along one side…Pawl 128 comprises a generally rectangular pawl body portion 132 possessing at its rearward extremity a slightly tapering rear surface 134 and a transverse aperture 136 through which extends the pivot pin 130…On the forward end of body portion 132 is a ratchet contacting and actuating foot 138 which cooperates with the longitudinally spaced ratchet teeth 140 located on the side of the bolt carrier 52 so as to move the bolt assembly 48 into the battery position. The teeth 140 extend along the length of carrier 52 a sufficient amount so that they are presented to the passage 100 regardless of the position of the carrier 52.."

136. Two bolt assemblies showing carriers with ratchet teeth on both sides for bolt closure devices mounted on right side (top; fig. 134) and left side (bottom; fig. 133). *Bob Miller collection, photo by Roy Arnold*



its position paper that during more than three years of testing and operation of the AR-15 rifle under all types of conditions, the Air Force "has no record of malfunctions that could have been corrected by the use of a manual bolt closing device".

The Air Force went on to list some other objections, pointing out that the modification would add to each rifle's weight, cost, and complexity, and could itself possibly induce other malfunctions. Not to be outdone, the Navy and the Marines also prepared formal position papers on the bolt closure issue. In a single paragraph the Navy explained that the device might be desirable in the event of certain "minor difficulties", but was not considered essential. In a similar short statement the Marines found it "non-essential", although if one were developed and proven to work well, the Marines were willing to consider it, provided it did not degrade basic rifle performance.

As regards the actual hardware, the addition of such a device where none had been intended was proving a difficult task in itself. By the summer of 1963 both Colt's and Springfield Armory had submitted designs, although initially none seemed completely satisfactory. Colt's first proposal had been a handle, attached directly to the bolt carrier, like the prototype AR-10A (fig. 36). This simply stuck out through a long slot milled in the upper receiver and reciprocated with the bolt carrier, thus allowing more dirt than ever to enter the action. Colt's second design eventually became the now-familiar ratchet-style "button" working through a modified upper receiver.

As Gene Stoner noted, Springfield had studied the problem from the standpoint of the least possible modification, and hence cost. They too had proposed two concepts, the first being to modify the upper receiver, charging handle and bolt carrier key, adding only a small spring and plunger to the total number of existing parts. A second Armory model was also in the design stage at this time.

Meanwhile, quite aside from the developmental hardware problems, the debate over the necessity for a bolt closure capability grew hotter. Secretary McNamara's original ground rules for the TCC had specified four-service agreement on all modifications before they could be adopted, but a resolution to the bolt closure issue seemed farther away than ever. In September, the Army's Assistant Chief of Staff for Force Development (ACSFOR) informed McNamara that the AR-15 rifle was "an unsatisfactory weapon for Army procurement and use, based on a reaffirmation of the essentiality of a manual bolt-closure capability and in consideration of the inherent risk of inadvertent fire." The Air Force, for its part, had run its own tests on the latest bolt closure designs from Colt's and Springfield, concluding that both were "unsatisfactory and unacceptable...it is recommended that the [TCC]drop further consideration of both..designs."

On October 12, Secretary Vance reported to McNamara that the Army still insisted the bolt closure was "mandatory", while for the Air Force it was "neither necessary nor desirable". As discussed below, other pressing problems soon overshadowed the pros and cons of the bolt closure issue, thus forcing a compromise on Secretary McNamara'a original plan of "one rifle" for all.

The "Slamfire" Problem

This third major problem was different again, if only that it was ***nobody's*** pet project. During the increased "hands-on" scrutiny being given the AR-15 by all four services, the Air Force and the Marines had reported that when a cartridge was single-loaded into the chamber and the bolt release pressed, their rifles sometimes fired inadvertently. Bill Davis recalls the mood of the first Washington meeting convened by the TCC to discuss this problem:

> *..When I arrived, I did not recognize any of my acquaintances in the small arms technical community, except a top-management official from Remington. This did not greatly surprise me, as I had been told that "Ordnance people" were excluded, insofar as possible, from all deliberations involving the AR-15 and its ammunition. I introduced myself to the group, and conveyed the assurances of my commanding officer that the technical resources of Frankford Arsenal would be at their disposal, and we stood ready to cooperate in their effort in any way possible. This opening remark was met with stony silence, and the meeting got under way.*
>
> *I soon discovered the topic of conversation would be "high primers" in the .223 Remington ammunition, the inquisitors were representatives from OSD, and the accused was the official from Remington. There were no specimens of ammunition exhibiting "high primers" available for examination, and the man from Remington reported that their most careful investigation had disclosed none in the ammunition that they had inspected. The evidence, it was said, was that AR-15 rifles sometimes fired prematurely upon closure of the bolt. I ventured to inquire whether any other untoward result of this premature firing had been reported, and was told that*

137. An early Colt model (6)02 (XM16E1) showing the bolt closure and modified charging handle contour, but still fitted with the early chromed bolt and original "heavy" firing pin.

there had not. I felt obliged to say, therefore, that "high primers" could hardly be the cause of the premature firing, else the rifle would have fired before locking, and the consequences of an unlocked firing could hardly have escaped attention.

I sensed immediately that my disagreement with the inquisitors was regarded as quite presumptuous, rather as if I had recited some horrible heresy aloud in church. The conversation did turn to other matters, however, leaving the "high primer" issue ostensibly unresolved. I returned to Frankford...somewhat the wiser about who was actually in charge of investigating the technical problems that were being experienced with the AR-15 system, the expertise of the investigators, and the degree of cooperation that I could expect from the emissaries of OSD. Back at Frankford...we then set about the investigations [described below]..

Once the "high primer" idea had been officially ruled out, there seemed at first glance to be two possible solutions to the "slamfire" problem: either modify the rifle's firing pin, or the cartridge primer. (At length, the solution was found in a contentious combination of both). Right away, however, Colt's, still miffed at the continuing holdups on the production contract, stated flatly that any modification to the rifle in the firing pin area would constitute a major redesign program. The TCC, with Frankford's assistance, therefore concentrated initially on modifying the sensitivity of the primer:

Frankford Arsenal

First Memo Report on AR-15 Rifle/Ammunition System

Investigation of Firing Pin Energy and Primer Sensitivity

4 April, 1963

Background

The incidence of premature firing has in some trials been reported infrequently or not at all, and in other trials with rather high..[and] undesirable frequency..

Procedures and Results

..To determine the energy of the [AR-15's] firing pin blow which results accidently from [ten trials of] the inertia of the pin upon bolt closure..

Indent Depth, Inch:	*Rifle No. 007237*	*Rifle No. 007249*
Average	*.0078*	*.0061*
Maximum	*.0090*	*.0075*
Minimum	*.0065*	*.0045*

Firing Pin Energy, Ounces:		
Average	*11*	*7*
Maximum	*14*	*10*
Minimum	*8*	*4*

..assistance was sought from Springfield Armory, who had made some kinematic studies of the AR-15 cycle. Their time-displacement curves for the bolt carrier show that its velocity in the instant of being arrested by impact with the bolt head is about 12 feet per second. As the mass of the firing pin is about 163 grains, and its velocity is the same as that of the..carrier on impact, it can be calculated that the kinetic energy of the pin at that instant is about 10 inch ounces..

It is clear that the matter of firing-pin energy..should be related to the..primer-sensitivity range in the ammunition. The first question, dealt with above, involves the limit of primer sensitivity which must be respected to avoid accidental firing. The second..question involves the other limit of the primer-sensitivity range, which must be respected to avoid misfires..

The firing-pin-indent fixture..[was] used to obtain the depth of indent made by [ten trials of] the firing pin when struck by the hammer, in the normal manner of firing the AR-15 rifle...A summary of these data follows:

Indent Depth, Inch:	*Rifle No. 007237*	*Rifle No. 007249*
Average	*.0234*	*.0220*
Maximum	*.0245*	*.0230*
Minimum	*.0225*	*.0210*

Hammer-Blow Energy, Ounces:		
Average	*84*	*77*
Maximum	*89*	*82*
Minimum	*80*	*72*

..No equipment is yet available at Frankford Arsenal for making primer-sensitivity tests on .223 ammunition. However, [Remington] has made available..information, which indicates that the primer used in production of the commercial .223 cartridge is comparable to that used in caliber .30 Carbine military ammunition. The sensitivity range of the caliber .30 Carbine primer is from a "none-fire" limit of about 6 inch ounces..to an "all-fire" limit of about 36 inch ounces, which are prescribed in military specification requirements. The tolerances demanded by the manufacturer for the commercial .223 primers are within this range.

Observations and Conclusions

In light of the fact that the AR-15 rifle characteristically may allow the primer to be struck by a firing-pin blow of about 10 or 15 inch ounces upon closure of the bolt, it is clear that the energy threshold of primer functioning should be safely above this figure to guard against accidental premature firing. Considering that the "none-fire" criterion of the .223 primer is only about 6 inch ounces, it is somewhat surprising that premature firing has not been more frequent ...The threshold of energy, below which primers must not fire, must clearly be above 15 inch ounces for safe and satisfactory use in present AR-15 rifles.

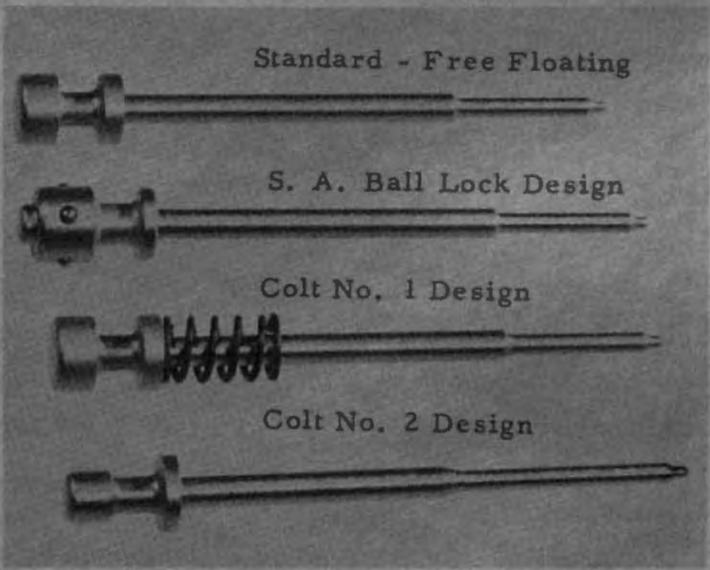
Wm. C. Davis, Jr.,
AR-15 Project Director

The TCC met at Springfield Armory on June 25 to discuss the results of the Frankford Arsenal primer sensitivity investigation, which had included a discussion of a theoretical primer which would all fail to fire at a force of 16 inch ounces but would all fire at 64. When it was learned that such a primer would produce an inadvertent fire probability in the AR-15 of only "1 in 10 million", a "coordinated Army staff position" plumped immediately for the 1 in 10 million risk factor, despite the fact that primers made to the required specifications did not actually exist.

A compromise of sorts was worked out on paper, and the two main suppliers of cartridges, Olin and Remington, were asked to bid on cartridges loaded with primers having 12 to 48 inch ounce none- and all-fire thresholds, to which Frankford had assigned an estimated 1 in 6,400 probability of inadvertent fire in the AR-15. Neither contractor would even bid on the project, stating that trying to produce primers to such limits was too tricky in large volume, and would lead to very high lot-to-lot rejection rates. At a further ammunition meeting at Frankford early in September, the Arsenal staff nevertheless advised the TCC not to relax the 12 to 48 inch ounce limits, at the risk of an unacceptable probability of inadvertent fire in the AR-15. Remington estimated that they would have to reject 50% of such primers made, but gamely agreed to try if the Army would allow the primers to be accepted or rejected *before* being loaded, thus preventing the rejection of an entire lot of ammunition solely on the basis of faulty primers. Olin estimated they would reject two out of every three lots of primers made to such limits. Two weeks later, they revised that figure upwards, to 90%.

Down to the Crunch on the "One-Time Buy"

Meanwhile, with both the "slamfire" problem and the bolt closure debate still unresolved, the TCC was being forced into a compromise position due to time constrictions soon to be imposed by simple economics at Colt's. Not just another arsenal to be ordered around at will, Colt's was a private company with a normal, not to say desperate, concern for the "bottom line". As such, Colt's faced imminent financial ruin as a result of the government's *double* stranglehold of delays in domestic acquisition and embargo on foreign sales. The firm had already advised the Army that as soon as current obligations (notably the 1962 Air Force contract for 8,500 rifles) were fulfilled, they would shut down and dismantle the AR-15 assembly line in order to reassign both the men and machinery involved to other, more profitable tasks.



138 With special primer development holding up the solution to the "slamfire" problem, Colt's and Springfield Armory undertook an examination of how to lighten or somehow restrain the AR-15's firing pin. Colt's "No. 2 Design" was at length chosen as the best approach.
Springfield Armory photo dated December 3, 1963

Finally, on October 25, in the face of continued indecision on the primer sensitivity and firing pin modifications, Defense Secretary McNamara sent a memo to Army Secretary Vance, relenting on his hitherto unbending order that all four services agree on "one rifle". Even at this eleventh hour, he obviously hoped that the Army would come to its senses over the bolt closure idea, which he had vigorously opposed:

> *..Since the AR-15 line [at Colt's] now producing Air Force rifles must close unless immediate action is taken, you should initiate all planned procurement at once. To satisfy the disagreement about bolt closure, the requirements of the Air Force should be procured without this modification. The Army may procure the rifle with the Colt designed manual bolt closure. In case your field tests, to be completed by 20 December 1963, indicate a lack of need for the bolt closure modification, the Army is authorized to revise its order to the same design being procured for the Air Force. Likewise, a selection of the bolt and pin modification to insure against inadvertent fire can be made as late as one month from contract without significant effect on deliveries.*

The Army's First Contract (DA-11-199-AMC-508) for M16 and XM16E1 Rifles

139. The long-awaited moment of signature on the Army's "one-time buy": Colt Firearms president David C. Scott puts pen to paper on contract "508", initially worth $13.5 million, while AWC Deputy Commander Brigadier General Roland T. Anderson looks on. US Army photo dated November 4, 1963

Contract "508", worth $13.5 million, was thus approved by the Secretary of Defense on October 25 and finally awarded to Colt's on November 4th, 1963. Numerous amendments and upward revisions of the dollar amount and quantities of rifles involved kept this "one-time buy" contract in a virtually continuous state of flux. The basic procurement contract called for 104,000 rifles: 85,000 with the Colt-designed bolt assist, designated the XM16E1, for the Army and the Marines at a unit cost of $121.84; and the remaining 19,000, called simply the M16, for the Air Force at a flat $112.00 each. The only differences concerned receiver markings and the bolt assist feature.

The Eleven Pre-Production AR-15 Modifications

140. Closeup of the receiver markings on a Colt AR-15 model (6)02, the precursor to the XM16E1, serial no. 021304. Black-impregnated furniture, redesigned charging handle, 1-in-12 rifling, modified bolt release and "type 2" flash suppressor. Photo credit: Eric Long, Smithsonian Institution

Eleven basic "improvements" were incorporated into the existing Colt AR-15 design before M16 production began under contract "508". These initial changes are listed below, with a brief explanation of the background of each:

1. Black-impregnated furniture

As originally marketed by Colt, the AR-15's "fibrite" furniture was a mottled brown color, wherein the composition of compressed fibers was clearly visible. Later, these had been painted green, a rather unsatisfactory process which scratched or wore off after relatively little use. The one-time buy contract specified that hereafter the stock, handguard and pistol grip were to be impregnated with a black coloring agent.

2. Chamber dimensional change

This resolved the dimensional interferences between chamber and cartridge, as discussed above.

3. Charging handle redesign

The original, a sort of serrated 45° triangle shape, was found to be rather difficult to operate under some conditions. The new T-shaped handle provided a more positive grip.

4. Front sling swivel

Complaints had been received about the plain metal front sling swivel, which could rattle noisily. It was henceforth to be coated with black plastic.

5. Firing pin redesign (fig. 138)

Finally incorporated as part of the TCC's "field fix" for the inadvertent fire problem, in conjunction with the adoption of less sensitive primers. After attempts by Colt's and Springfield to spring-load or otherwise partly restrain the firing pin, it was finally agreed to use a Colt idea which simply lightened the pin's total mass, thereby decreasing the force of its "bounce" off the primer.

6. Bolt closure device (XM16E1 only; fig. 135)

Having seen so many of the reasoned proposals and conclusions of his technical staff overridden by OSD veto, even the dutiful Harold Yount later unbent to the point of telling the Ichord subcommittee that his testing had in fact not justified the bolt closure device, and that it had been included on the Army's rifles solely "on the basis of direction". Significantly, the subcommittee declined to pursue this line of questioning any further.

7. Rifling twist modification

Tightening the twist from 1 turn in 14 to 1 turn in 12 inches improved bullet stability, and hence accuracy, especially in subzero weather. As mentioned, the great rifling twist controversy returned to dog the heels of the TCC in the years to come (chapter 14).

8. Bolt release modification

A slight redesign to ensure more positive function and longer part life.

9. Flash suppressor modification

The distinctively sculptural open prongs of the Colt model 01 were beefed up somewhat, to avoid bending or breakage during rough handling.

10. The original Colt 20-round "waffle" magazines (fig. 406 no. 2) were made of steel, which rapidly corroded. Still a Colt proprietary item, they were henceforth made of aluminum (fig. 406 no. 3).

11. The old front takedown pin, which held the upper and lower receivers together, was completely removable, and hence easily lost. The new design was fitted with a spring-loaded detent which checked the pin after it was pulled out just far enough to free the upper receiver.

Towards a Standardized .223 Cartridge

The Discovery of Fundamental Limitations

The Army had ordered a final 600,000 rounds of commercial .223 Remington ammunition back in May 1963, to support its continuing evaluation of the AR-15/M16 system. With a view to formulating the Military Characteristics (MCs) for the planned FY64 ammunition procurement, the TCC had, as part of the same contract, also acquired Remington's Technical Data Package (TDP) on the .223 cartridge. This consisted of all the specifications and technical data used in the commercial manufacture of the round. Over the summer, investigations by Bill Davis' AR-15 team at Frankford Arsenal revealed some serious discrepancies:

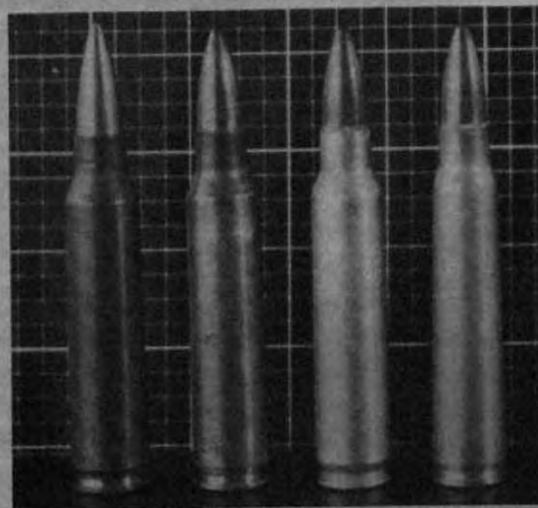
As we found very soon..the claims made for the ballistic performance of the .223/5.56mm cartridge, by ArmaLite, Colt, Remington, Stoner, OSD (ARPA) and other vocal proponents of it, had been considerably exaggerated. Examination of the records at Remington, and testing of samples from lots of .223 ammunition..previously produced by Remington, disclosed that the claimed muzzle velocity of 3,300 fps simply could not be attained consistently, within the maximum acceptable chamber pressure of 52,000 psi (radial copper), using the IMR4475 propellant which had been employed in the loading. This should not have been very surprising, because the powder capacity of the cartridge is simply insufficient to accommodate the necessary charge, of an IMR propellant of suitable relative quickness, to meet those ballistic requirements. Gustafson and I had examined the question of the powder capacity reqired to produce precisely those ballistics, when we proposed the development of such a cartridge at Aberdeen in 1955 [chapter 3]. It was our intention to base the experimental cartridge on the commercial .25 Remington cartridge case, which is larger by about .045" in body and head diameter than the .222 Remington family, in order to obtain the necessary powder capacity for

IMR-type propellants in a cartridge that was not undesirably long...Stoner's design of the cartridge..has inherently insufficient powder capacity to meet the stated ballistic requirements when using the powder claimed to be of his own choice..

Genesis Denied - A Display of Blind Arrogance

As we have seen, Gene Stoner originally set out to "design" a cartridge to satisfy General Wyman's *300-yard* range requirement. In his own words he has related that his ".222 Special" case was simply a lengthened .222 Remington. As an example of how this and other basic facts were denied credence by Stoner's OSD disciples, Bill Davis relates an incident he witnessed at a top-level Washington conference during the M16 controversy:

..the senior general officer present happened to be speaking about the origin of the 5.56mm military cartridge, and commented that it had evolved from the commercial .222 Remington round. At that moment, the OSD man entered the room, and hearing the general's comments, slammed down the pile of documents that he was carrying so that they scattered all over the conference table. He launched into a tirade of incredible ferocity, to the effect that Gene Stoner had personally designed the 5.56mm cartridge in its entirety, and he would countenance no more denigration of Stoner's efforts by anyone in the Army..



141. Evolution of the .223 cartridge. From left: 1. Gene Stoner's original unheadstamped "stretched" .222 Remington, loaded with his 55-grain bullet, identified as "Type B" in Frankford Arsenal's Investigation of Bullet Configuration *report of June, 1963; 2. The .222 Remington Special, loaded with Remington's 55-grain 5.5-caliber tangent ogive bullet (the inferior "Type A" in the Frankford report), headstamped REM - UMC 222 SPL (fig. 76); 3. A typical M193 5.56mm round, (actually an inert, nickel-cased "Display" version of Fabrique Nationale's M193 counterpart) headstamped FN 75; 4. An interesting experimental "tapered case" .223 round by Fabrique Nationale, headstamped FN 68. Editor's collection*

Stoner's Last Word

Davis hastens to add that he does not suggest Stoner himself was behind this exceedingly unfortunate blind reverence for the .223 cartridge, nor that he would have condoned it.

..The .223 round is still being loaded to the original specifications I gave them in 1957. I have had several conferences with Remington in the past years on improving this round, but they seem to be reluctant to change anything. I believe that a great deal could be done to this round to improve its military characteristics. It is inconceivable to me that

In the final paragraph of his own personal, handwritten history of these events, prepared as background information for Bobby Macdonald in 1964, Gene Stoner seems to concur:

the first attempt would result in the best combination of bullet weight, powder, primer, case design, etc.

yours truly,

E. M. S.

The Self-Manufactured Chamber Pressure Problem

At Remington, meeting the .223 "design goals" had not presented much of a problem up to this point because DuPont's proprietary IMR4475 powder was being produced in vast quantities for contract loading of 7.62mm NATO ammunition, and Remington could hitherto afford to "pick and choose" among powder lots to meet the very tight .223 pressure/velocity specifications. Olin had meanwhile picked up the 7.62 NATO contract, however, and was of course loading with their own proprietary ball powder.

OSD refused to give credence to Frankford's warning that over the long haul the .223 cartridge was incapable of meeting the stated design goals when using any and every lot of IMR4475 powder. The Gilpatrick directive had proclaimed

that the AR-15 was already a fully developed system, and therefore the Defense Department insisted that the TCC adopt the original *commercial design goals* as unalterable *military performance requirements.*

Bill Davis explains the three choices available under these circumstances:

..Given this fundamental limitation of the cartridge design, there remained but three possible alternatives, which were: (1) increase the acceptable chamber pressure; (2) reduce the required muzzle velocity; or (3) find a propellant of greater specific energy and/or higher gravimetric density so that a heavier charge could be accommodated within the limited case capacity. None of these was especially attractive, but there were nevertheless some grounds for choice among them.

Alternative 1 - Increased Chamber Pressure

Increasing the allowable chamber pressure was the least desirable. The expected adverse consequence..is an increase in the liklihood of expanded case heads and primer pockets, and consequently "dropped" primers which can jam the mechanism. This is especially likely if the ammunition is wet or oily. There were already complaints of "dropped" primers in the AR-15, both in simulated rain tests at Aberdeen in 1960 [chapter 6], and in the field under rainy conditions. The strength of the relatively small case head was clearly marginal at the chamber pressures [already] being developed. The resistance of the case head to expansion is a function of the case-head diameter and the tensile strength of the material. The case-head diameter, as "designed" by Stoner, obviously could not be increased. It was questionable whether the problem could be solved by imposing..more stringent metallurgical requirements on the case material..and in any event that is imprudent practice in the design of military ammunition which must be produced in great quantities during times of emergency.

Alternative 2 - Reduced Muzzle Velocity

[This]..was more feasible. The reduction of a few percent in the muzzle velocity would have relatively little effect on lethality of the bullet in any event, and if coupled with a bullet of more favorable aerodynamic design, the lethality at the longer ranges (where the velocity is inevitably reduced and the difference is thus more critical) could actually have been enhanced..

This gives rise to the extremely interesting topic of optimum bullet configuration. In the course of AR-15 testing at Frankford it was noted that commercial .223 cartridges had over the years been procured and issued with at least two types of bullets. As Bill Davis points out, velocity is indeed part of the lethality equation but it is *terminal* velocity - the speed of the bullet when it reaches the target - that counts:

Frankford Arsenal

Third Report on AR-15 Rifle/Ammunition System

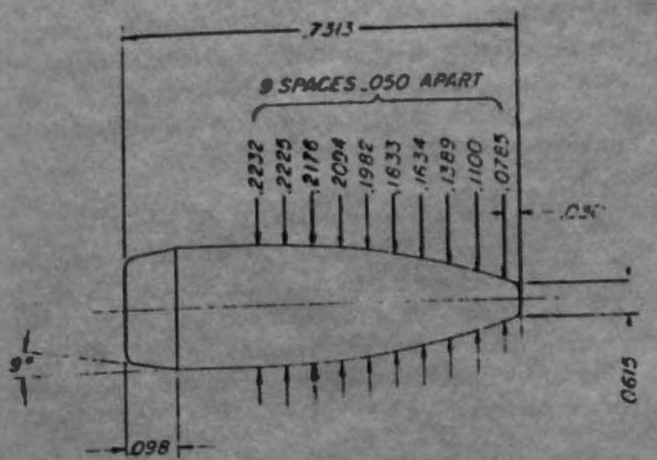
Investigation of Bullet Configuration

18 June 1963

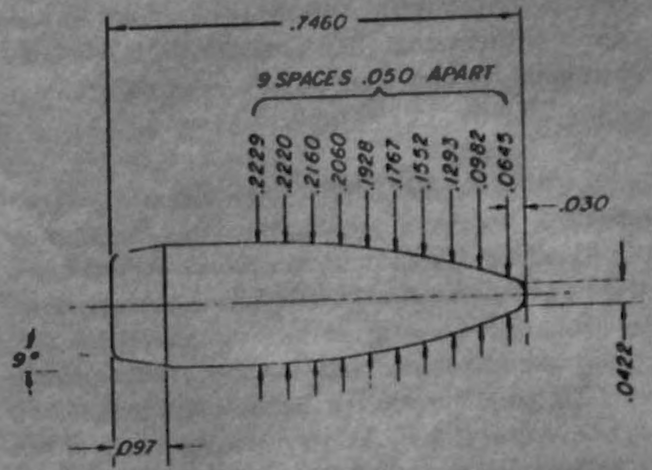
Introduction

It appears that bullets of several different shapes have been made by various manufacturers at various times, and used to some extent in ammunition for the AR-15 rifle...

The two types of bullets which were available for testing were..'"Type A"..taken from cartridges manufactured by the Remington Arms Company..and contained in various lots of .223 ammunition procured under government contracts..." Type B" were procured by the USAF..as separate components ..from the firm of Sierra Bullets, Whittier, California...

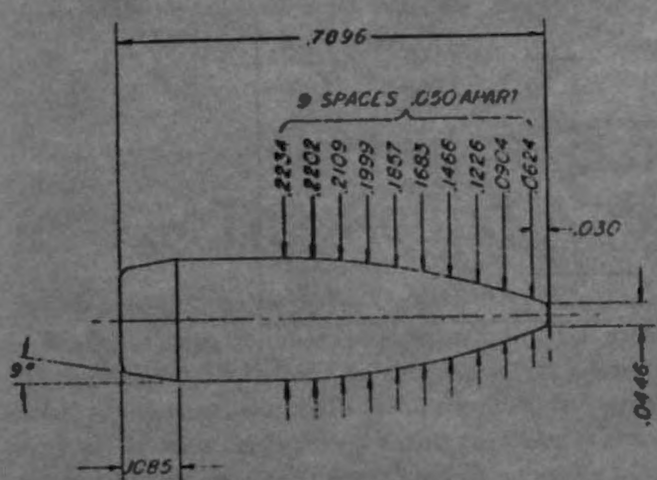


TYPE A BLUNT

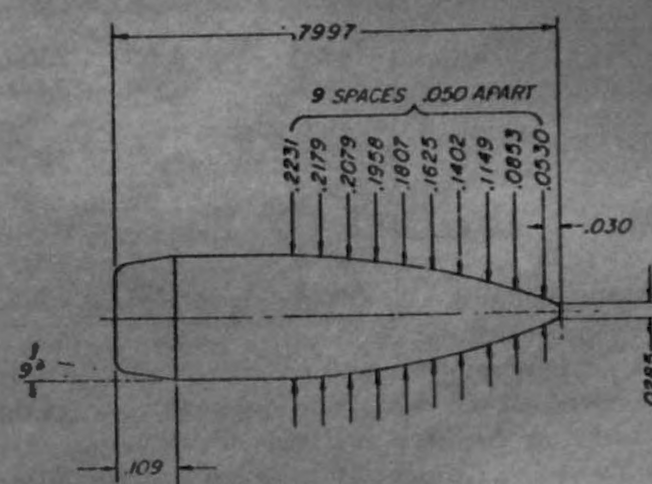


TYPE A SHARP

142. A drawing from Frankford's Investigation of Bullet Configuration *report. Stoner's original "Type B" (below and fig. 141 no. 1) features the same ogive and boattail as the 1954 Frankford Arsenal 68-grain, .22 caliber M1 ball homologue (fig. 72). Tests showed the easier-to-make Remington "Type A" (above) to have "a less favorable aerodynamic shape".*



TYPE B BLUNT



TYPE B SHARP

Each cartridge..was fired over a 300-yard range indoors. Measurements were made of instrumental velocity at 40 feet.. and..875 feet from the muzzle, and time-of-flight was measured over 835 feet...A barrel having a 12-inch twist was used for this firing.

The data..were reduced..to yield ballistic coefficients... form factors [and] meplat [the small flat on the very tip of the bullet] diameters.

Results

The Type A bullets had generally "blunter" points than the Type B bullets...The Type B [Stoner] bullet resembles in its salient features some successful military bullets of other types. The [same] 7-caliber ogive and 9° boat-tail are employed in the .30 caliber M72 Match bullet...A 68-grain caliber .22 bullet homologous with the M1 Ball was designed and tested experimentally, with good success, in 1954 at Aberdeen ...The configuration of the Type B bullet tested for this report differs from these other bullets only in that the overall length is reduced somewhat to achieve the desired weight of 55 grains.

As might be expected from their differences in shape, the Type B bullets had very significantly higher ballistic coefficients (less drag) than did the Type A...The accuracy..was nearly the same when both were fired from barrels having a 12-inch twist..and was in both cases very satisfactory by

comparison to the..performance requirement which has been applied to commercial .223 ammunition obtained under government contracts [average MR (mean radius) not to exceed 2.0 inches at 200 yards].

..it appears that the 12-inch twist of rifling affords a small advantage as regards aerodynamic drag...The practical significance of differences in aerodynamic drag of Type A and Type B bullets is clear from the following considerations.

a. If both..bullets were loaded to a nominal muzzle velocity of 3,270 fps (corresponding approximately to 3,250 fps instrumental at 15 feet), then the remaining velocity of Type B bullets would be about 130 fps the greater at 100 yards, and about 185 fps the greater at 500 yards.

b. If Type A bullets were loaded to the present nominal muzzle velocity of 3,270 fps, and Type B bullets were loaded so as to produce the same impact velocity at 300 yards, then the muzzle velocity of the Type B bullets could be reduced by 154 fps, to a level of 3,116 fps.

If Type B bullets were loaded to the present nominal muzzle velocity of 3,270 fps, and Type A bullets were required to produce the same impact velocity at 300 yards, the muzzle velocity for the Type A bullets would be 3,426 fps, which is an increase of 156 fps above present levels; this is, of course, not attainable with the present design parameters of the cartridge.

The following tabular data..illustrates the foregoing considerations, and gives additional data at other ranges.

Bullet	Impact Velocities, feet per second					
Type	Muzzle	100 yds	200 yds	300 yds	400 yds	500 yds
Type A	3,270	2,984	2,540	2,211	1,908	1,627
Type B	3,270	2,944	2,633	2,341	2,068	1,814
Type A	3,270	2,894	2,540	2,211	1,908	1,627
Type B	3,116	2,797	2,494	2,211	1,948	1,701
Type A	3,426	3,043	2,680	2,341	2,028	1,738
Type B	3,270	2,944	2,633	2,341	2,068	1,814

Observations

The muzzle velocities of bullets are frequently discussed as if they represented the principal index of relative terminal effectiveness, and great importance is sometimes attached to these numbers per se*...Less commonly appreciated is the fact that* impact velocities, *and not muzzle velocities, are the more significant as regards terminal effect...In the case of .223 ammunition, the retardation near the muzzle is nearly 4 feet per second in each yard of range. It is obvious, therefore, that a change of 50 fps in muzzle velocity..is equivalent to a difference of about 12 yards in range. However, the difference in impact velocities ascribable to the difference in drag between Type A and Type B bullets..is equivalent to a difference of about 40 yards in range, at..approximately 300 yards. The use of bullets having efficient aerodynamic shape is of significant importance because their superior exterior-ballistic properties allow lower muzzle velocities without sacrifice of terminal effects, and thereby facilitate solution of the interior-ballistic problem of maintaining safe chamber pressures in loading.*

Conclusions

The Type B bullets evaluated..have significantly better exterior-ballistic properties than have the Type A bullets, with which latter type the system evaluation has largely been conducted to date.

The use of bullets having a more favorable aerodynamic shape (such as Type B) would allow a reduction of 50 fps in muzzle velocity, thereby reducing the probability of interior-ballistic problems which might arise in large-scale loading of .223 ammunition, and [would] still provide higher impact velocities at 100 yards and all greater ranges.

It appears that Remington had not been able to mass-produce acceptably accurate bullets to Stoner's original drawing, due to the marginal stability problem in the 14" twist, as discussed above. Accordingly, they had redesigned the 7-caliber ogive bullet, giving it a shorter boattail and a shorter and "fatter" (5.5-caliber radius) ogive.

Bill Davis comments further on this quiet switch from Stoner's "original" bullet to the 55-grain Remington design:

..It was clearly a necessary measure, given the fundamental problem of marginal stability inherent in Stoner's choice of the 14" twist with his chosen bullet configuration. [As noted above] the changes had the concomitant effect of increasing aerodynamic drag, however...Furthermore, the improvement in gyroscopic stability was not enough, as [the subsequent change to 1-in-12] made clear.

..I inquired into the reasons for the changes, and found they had been made rather quietly by Remington, for reasons that Remington officially declined to disclose to the Army...The reluctance on the part of Remington to discuss the matter was said..to have resulted from a telephone call to a Remington top-management official, by an officer who claimed to represent the OSD position, warning him that any further discussion of the matter between Remington and the Army would be regarded with great disfavor by OSD. Remington.. apparently decided thereupon that discretion was the better part of valor in this delicate matter, and no further cooperation was received officially from them in the matter of bullet design and twist of rifling.

..From information I was able to gather at the time, it appeared that most of the partisan advocates of the AR-15 system in the great controversy were unaware that the .223 ammunition being manufactured by Remington did not actually contain bullets corresponding to Stoner's original design, until the comparisons made at Frankford..in early 1963 [above] revealed the difference..

"Cartridge, 5.56mm Ball, M193" - The Round Nobody Wanted to Make

The reversion to a bullet akin to Stoner's "Type B" (above) was Bill Davis' personal choice as a solution to problem of the .223's inherent inability to meet the cast-in-concrete pressure/velocity requirements with IMR4475 propellant, in volume production. He accordingly recommended this course of action to Lt. Col. Yount, who readily agreed and presented the idea, along with Frankford's supporting documentation, to the TCC. Here it was summarily vetoed by the OSD representative, who declared that this proposal, which would have avoided the chamber pressure problem altogether with even better resulting bullet lethality, had "insufficient merit to justify a reevaluation".

"Cartridge, 5.56mm Ball, M193" was officially adopted on September 27, 1963. Unfortunately, Frankford's reasoned advice had been disregarded on three counts. First, the M193 specified the inferior "Type A" Remington bullet over the more aerodynamic and hence more lethal original. Secondly, having made this crucial decision, there could be no reduction in muzzle velocity, in order "not to degrade the lethality of the [Remington] bullet". Finally, the TCC was guaranteed a host of future headaches by the reaffirmation of IMR4475 as the only approved propellant, *and* the 52,000 psi ceiling on allowable average chamber pressure limits.

All three approved commercial ammunition manufacturers promptly declined offers to bid on the M193 round as defined by the specifications. To quote from the PMR's significant action report of 16-20 September:

The FY64 ammunition procurement program has been suspended because ammunition manufacturers have stated that under the present state-of-the-art, American industry cannot manufacture ammunition within the limits imposed by Army staff.

Over the new year, with deliveries of the first M16 and XM16E1 rifles just a few months away, the FY64 ammunition requirement rose to 132 million rounds. The stalemate persisted, with all three approved commercial manufacturers, Remington, Olin Mathieson (Winchester/Western) and the Federal Cartridge Co., still refusing to bid. The 13-17 January 1964 PMR's report describes a compromise which, although it permitted the manufacture of the necessary "Specification Verification Quantity", did not solve the problem:

..As a result of review of [specifications] for procurement of M193 Ball Ammunition, commercial..producers advised that certain prescribed requirements..could not be met.

The project manager discussed this problem with the services involved and formulated a solution which was presented to three of the cartridge producers and the propellant producer in a meeting at Frankford Arsenal on..17 January.

This solution was to increase allowable average chamber pressure from 52,000 psi to 53,000 psi, and for retest only, to increase allowable individual round chamber pressure from 58,000 psi to 60,000 psi.

All producers reacted favorably with respect to the first procurement of one million rounds, but the propellant manufacturer would not make a firm committment on being able to meet the specifications for the 131,000,000 round procurement to follow.

Thus the "solution" was temporary at best, amounting merely to a waiver on the first million rounds, but leaving the actual specified pressure limits for future production untouched. Significantly, upon completion of their 500,000-round portion of the Specification Verification Quantity, Remington withdrew IMR 4475 from use as a propellant for 5.56mm ammunition.

Other methods of curing the self-generated chamber pressure problem were sought and eventually found, but at a cost which the Army would later be forced to admit was too high.

As we have just begun to explore, the design of an automatic firearm is somewhat like a miniature, speeded-up model of a universe wherein bodies interact within units of time measured in micro- and milliseconds, but are nevertheless linked in a chain of cause-and-effect relationships with the inexorability of planets orbiting a sun.

Further to this cosmic analogy, the eminent British biologist and scientist J. B. S. Haldane, in a paraphrase of Gertrude Stein, once commented on his suspicion that the universe is "not only queerer than we suppose but queerer than we can suppose." As we shall see, these were fateful words indeed for the TCC.

END OF PART I

PART II - TENDING A NEST OF VIPERS

Chapter Nine

TACKLING THE CHAMBER PRESSURE PROBLEM THE HARD WAY

A series of fruitless meetings, held throughout the early part of January 1964, failed to solve the impasse created by the OSD's adamant restrictions on allowable average chamber pressure. Remington and Olin had finally agreed to split the one-million-round Specification Verification Quantity to be loaded under the PMR's waiver, each signing up to supply 500,000 rounds by April at the latest. However, no firm bids had as yet been received for the FY64 procurement of M193 ball ammunition, which had now risen to 164 million rounds.

The Third Alternative - The Search for Alternate Propellants

Continuing the discussion of the three alternatives to the chamber pressure problem, Bill Davis notes:

> *..Of the three physically possible alternatives, the first [higher chamber pressure] was manifestly undesirable, and the second [use of the "Type B" bullet] was summarily foreclosed by OSD. The only remaining one was to seek another propellant for use in .223/5.56mm ammunition., and the search for an alternate propellant was thus unavoidable..*

With ammunition production stalemated and initial M16/XM16E1 rifle deliveries now only two months away, it appeared that one or another of the M193's specifications would simply have to give way. As noted in the following report, however, Frankford was already setting up a careful study of the "third alternative". They requested permission to buy outright and then test 25,000-round lots from each and every interested supplier, loaded with whatever propellant the supplier recommended, in an all-out effort to find a solution to what was now out in the open as "the unsatisfactory velocity/pressure relationship" exhibited by IMR4475. The PMR recorded swift TCC agreement to this proposal, announcing, "..If one or more alternate types of propellant are selected..contractual changes instead of specification changes will be considered."

In the ensuing response from industry, three candidate powders were put forward. DuPont, who had already announced the withdrawal of its original IMR4475, suggested another proprietary powder, CR8136. The Hercules Powder Company offered its HPC-10. Then Olin's Associated Products Operations, located in East Alton, Illinois, learned of the program and recommended their proprietary "ball" powder WC846.

Olin Bows In

Curiously, the TCC balked at even allowing Olin's double-base ball powder into the trials. Instead the issue was referred to AMC's Director of Research and Engineering, with the recommendation that Olin contact that office directly and restate their case in writing. This Olin promptly did, on January 21, in the following oiled introduction to their WC846:

..Our basic request is that of being permitted to participate in the competitive procurement of propellant required for FY64 production of the 5.56mm cartridge. We recognize that the only propellant currently approved by the Army is single base extruded propellant, and we further recognize that the approval of an alternate propellant will necessarily entail an evaluation by Frankford Arsenal. However, we feel that in this instance, the amount of evaluation needed to demonstrate acceptability is relatively minor..

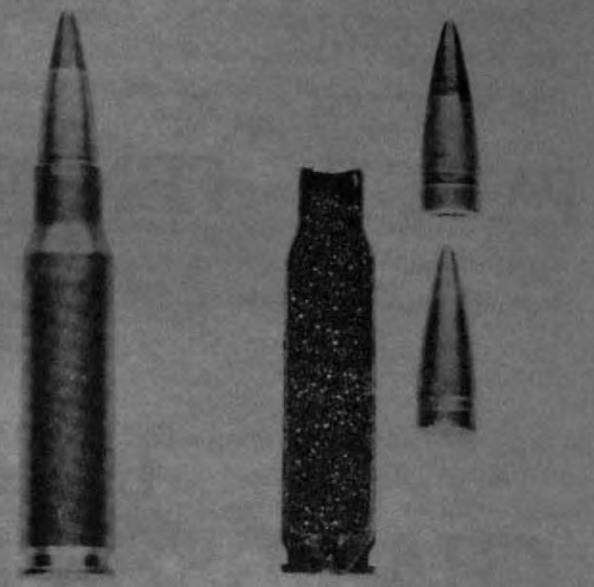
We are proposing WC846 BALL POWDER as an alternate propellant for the 5.56mm cartridge and are prepared to guarantee its compliance with applicable ballistic, physical and economical specifications without waivers. To support our contention..we offer the following facts:

1. More than 550 production lots of WC846 totalling over 12,000,000 pounds have been produced to date for the 7.62mm cartridge, and its basic acceptability as a propellant type is well established. Thus, in considering this propellant for the 5.56mm cartridge, it would appear sound to forego those evaluations normally conducted to ascertain chemical and ballistic stability, shelf life, and similar long term properties.

2. We are currently supplying WC846 to Remington Arms Company for loading 5.56mm ammunition under an Air Force contract. An initial pilot lot and at least one production lot.. have been accepted by the Air Force. [In] the..certification on the initial WC846 lot produced.. ballistic performance is well within the specifications and..the average [chamber] pressure level is well below the maximum permitted and will require no increase in..specification as is the case with extruded single base propellant...half of this 40,000 pound lot was supplied for 5.56mm loading and half for 7.62mm loading.

3. In discussions with Frankford Arsenal personnel..the only areas of performance where reservations were expressed were in regard to muzzle flash and fouling. We agree that these are two performance characteristics which would have to be examined prior to qualification..

It would appear that a review of all available test data and possibly some limited tests of a confirmatory nature would establish that WC846 is entirely acceptable for the 5.56mm cartridge and may, in fact, offer significant product improvements...We will appreciate your immediate consideration of our request..



143. Above: the green-tipped 7.62x51mm M198 Duplex round, adopted on May 7, 1964, shown loaded with Olin's WC846 ball powder. Note the dispersion-inducing 9° cant on the base of the lower bullet.
Below: the M80 lead-core ball version of the 7.62 NATO, loaded with DuPont's IMR4475. *American Ordnance Association*

Olin's proprietary ball powder was indeed by all accounts a remarkably satisfactory military propellant. For years there had been no attempt to segregate ball-powder cartridges from cartridges loaded with IMR powder, and both had been routinely intermingled and fired in all the Army's .30 caliber shoulder rifles and light machine guns with virtually indistinguishable results. In fact, such overwhelmingly favorable evidence as Olin submitted to AMC seems to beg the question of why the TCC didn't accept their offer in the first place. In any event, permission was swiftly granted for Olin to participate in the upcoming cartridge/propellant examinations.

In order to insure as much basic uniformity as possible, the powder manufacturers agreed to ship their propellants in bulk to Remington, where all three of the 25,000-round test lots were loaded: one with DuPont's newly recommended CR8136; the

second with Olin's WC846 ball powder; and the third with Hercules' HPC-10. The loaded cartridges were then shipped to Frankford Arsenal for the comparative study, where a control lot loaded with DuPont's original IMR4475 had meanwhile been procured.

The ground-breaking report of this first study on alternate 5.56mm propellants was prepared by Frankford's chemical engineer C. E. Schindler and the project director, Bill Davis. Excerpts are as follows:

Tenth Memo Report on AR-15 Rifle Ammunition System

Investigation of Alternate Propellants For Use in 5.56mm M193 Ball Ammunition

15 May, 1964

Introduction

The commercial caliber .223 ball ammunition..[made] before commencement of military participation in the..program was either entirely, or at least preponderantly, loaded with IMR4475 propellant. The stated ballistics of the commercial ball cartridge included a nominal mean velocity of 3,250+/-30 fps and a mean chamber pressure not to exceed 52,000 psi. Examination of the manufacturer's test reports, and the ballistic testing of some samples..led to the observation [that] "while these ballistics are attainable, the..required velocity has..allowed a very small margin below the maximum permissible chamber pressure for most lots of ammunition. For large-scale production of military ammunition..a somewhat more conservative margin should be maintained between the typical *chamber pressure of production lots and the* maximum *level permitted." It was recommended..that consideration be given to a reduction in muzzle velocity (which would permit lower chamber pressure) and concomitant adoption of an alternate bullet having improved aerodynamic design...This recommendation was not approved however.*

Subsequent development confirmed..that, whereas the stated commercial ballistic requirements frequently were met by individual lots..occasionally the requirements were not met [with IMR4475]. It appeared that consistent compliance ..would demand very close control of lot-to-lot variables, especially..the velocity/pressure relationship of the propellant.

In the absence of any manufacturing experience under government cognizance, it could not be established whether the latitude allowed between the design capability and the stated ballistic requirements..was sufficient to permit economical mass production.

..[Thus]..the liklihood that some change in the design of the commercial .223 cartridge might be required if the stated commercial ballistic requirements (now adopted as military requirements) were to be met consistently, in large-scale production...Accordingly, Frankford Arsenal immediately sought and was granted permission to commence on a high-priority basis a product-improvement effort to find means of improving the velocity-pressure relationship of the 5.56mm Ball cartridge.

The task..was to find a propellant (or propellants) which would allow..the required velocity of 3,250 fps at a chamber pressure substantially less than that produced by IMR4475... any [such] propellants should be not significantly inferior to IMR4475 in..smoke, flash, fouling, barrel erosion, storage stability, or performance at environmental extremes..

The foregoing requirements were made known to the three US producers of small-arms propellant, who were each invited to make available for purchase a test quantity of twenty-five thousand (25,000)..Ball cartridges...Frankford.. purchased the test samples as agreed..

Description of Material

..The samples of propellant were confirmed to be of types which have shown satisfactory storage-stability in previous experience, which was a condition for their inclusion, inasmuch as urgency precluded conducting long-term storage tests within this program...A general description of the propellants..is as follows:

a. IMR4475:

This propellant is the type originally used in..commercial .223 ammunition...It is of a general type [Improved Military Rifle] (IMR) which has been in use for about thirty years, without fundamental changes...Propellants of this type are

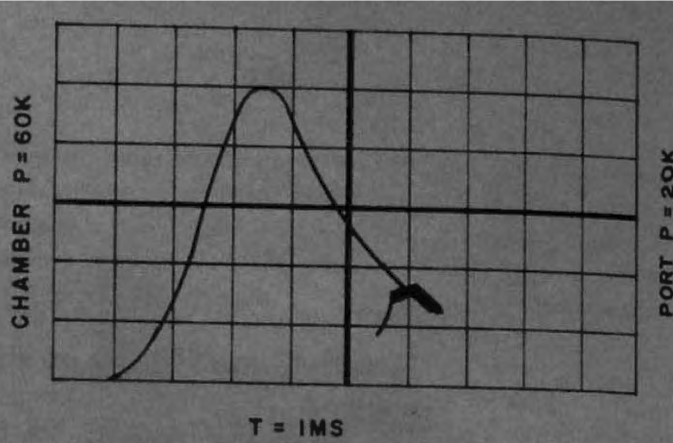
single-base (nitrocellulose), tubular grain, and employ DNT (dinitrotoluene) as a deterrent coating to control the rate of burning...In cartridges such as the caliber .30, for which the ballistic requirements are quite conservative in consideration of the cartridge-case capacity, propellants of IMR type have given very satisfactory service for many years... The..sample containing IMR4475 was included..for purposes of direct comparison and control in evaluating performance of the proposed alternate[s]..

b. CR8136:

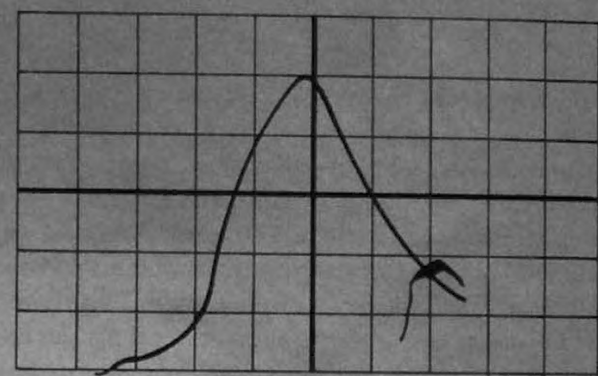
..recommended by..DuPont..[this] is a single-base, tubular-grain propellant, differing fundamentally from IMR types in that the deterrent coating is methyl-centralite instead of dinitrotoluene...The improved coating..reduces the flame temperature (and thus the barrel erosion), and affords somewhat better control of burning rate (and thus better control over velocity/pressure ratios)..

c. WC846:

This..was recommended by..Olin Mathieson...It is a double-base (nitrocellulose/nitroglycerine) propellant, commonly called "ball powder" (produced by spherical graining and subsequent rolling for adjustment of web), with a deterrent coating of dibutylphthalate. The preponderance of 7.62mm NATO ammunition of US Ball and Tracer types have been loaded with WC846...In cartridges of comparatively small capacity, the high density of ball propellant permits the accommodation of comparatively heavy charge weights, thus allowing rather wide latitude for adjustment of burning rate, and consequently for improvement of velocity/pressure ratio..



144. Typical pressure-time curves, chamber and gas port, for the 5.56mm M193 Ball cartridge.
Above: Lot TW-18205, loaded with Dupont's third try at an acceptable 5.56mm IMR propellant, 8208M (chapter 11).
Below: Lot LC-SP-556, loaded with WC846 ball powder.
Frankford Arsenal, redrawn by Thomas B. Dugelby



d. HPC-10:

This..is a double-base, tubular-grain propellant...Such propellants have..in the past been rather disadvantageous in regard to bore erosion...At temperatures approaching -65°F, the tendency has been for mean chamber pressures to increase considerably..so that individual shots sometimes developed excessive pressure..

Velocity and Pressure Tests

Each test series..consisted of 20 rounds. Two different barrels were used under each test condition with each sample..

Normal ambient condition: [Grand Averages, corrected].. ammunition.. conditioned and fired at +70°F.

	IMR4475	*CR8136*	*WC846*	*HPC-10*
Velocity, fps @ 15 feet	*3,225*	*3,205*	*3,224*	*3,244*
Chamber pressure, psi	*54,000*	*48,300*	*48,800*	*52,400*
Port pressure, psi	*14,400*	*14,800*	*15,400*	*15,200*

Observations

..All of the test samples were superior to the control sample as regards pressure/velocity relationship at normal ambient temperature, although it would appear (from previous experience with 5.56mm ammunition) that the pressure/velocity relationship of this particular..sample of IMR4475 was less favorable than is usual for that type of propellant..

Conclusions

The cartridge samples representing CR8136 and WC846 propellant indicate that propellants of these types are satisfactory for use in 5.56mm M193 ball ammunition, and can afford substantial advantage over IMR4475 as regards velocity/pressure relationship.

The..HPC-10 propellant..is not suitable..because the chamber pressures developed, especially at..-65°F, are excessive.

Recommendations

It is recommended that propellant types CR8136 and WC846 be approved for use as permissible alternates to IMR4475 in the loading of 5.56mm M193 ball ammunition.

Other portions of Frankford's 5.56mm alternate powder tests concerned such parameters as flash, erosion and fouling. No significant problems were revealed, at least as far as these various avenues were explored. Gas port pressure, for example, soon to stand revealed as a crucially important parameter, had been duly recorded with the prophetic proviso that:

..There are as yet no very soundly established port-pressure criteria for the AR-15 (M16) rifle...It might be expected, however, that the slower-burning propellants (such as CR8136 and WC846), which are required to improve the velocity/chamber-pressure relationship, would give in the long-run experience a slightly higher port-pressure level than that of IMR4475.

The Fateful Approval of Ball Powder

Meanwhile, the TCC had announced the awarding of a purchase order to Olin Mathieson's Winchester/Western Division for 13,000 rounds of 5.56mm XM197 High Pressure Test Ammunition (HPT) on February 3: at least here, ironically, there was no problem in meeting the pressure specifications. Also in February, with the Frankford alternative powder report still two months away and IMR4475 still the only powder officially approved for Army 5.56mm cartridge loading, all three cartridge manufacturers had placed tentative bids on a total of 150 million rounds of M193 ball, which, as noted in a Feb. 4 memorandum for record from the Project Manager:

..Of the 150 million total, 131 million rounds..are for the Army, and 19 million rounds..are for the Air Force...Quick analysis shows that none of the bidders bid on the full Army FY64 requirement, and that even the total of all three bids does not meet the Army requirement. Without having full information..no conclusion can be drawn as to what course of action will be taken...However, since there is only a 5 million round shortage apparent, it is believed that no significant problem exists.

This rather shaky arrangement had collapsed completely in March, when as mentioned Remington/DuPont, close to delivery on its half of the million-round Specification Verification Quantity loaded under waiver, withdrew IMR4475 from further

use in 5.56mm ammunition, thus leaving the entire program high and dry without any qualified propellant whatever. Fortunately, a month later the Frankford trial had come through in favor of the two alternate propellants, DuPont's CR8136 and Olin's WC846. These were approved for loading in M193 cartridges on April 28, 1964.

Having apparently solved the chamber pressure problem by direct appeal to the powdermakers, the TCC moved swiftly to revive the flagging negotiations with the three cartridge producers, Olin, Remington and the Federal Cartridge Co. Deliveries of M193 rounds loaded with these two new propellants were scheduled to run from June 1964 through to March, 1965. Initially, Remington elected to load with its proprietary CR8136, while the other two contractees chose Olin's WC846.

A Voice in the Wilderness

The TCC's approval of alternate propellants and less sensitive primers for the M193 cartridge had so far been done in a vaccuum, as it were, without the time or budget for extensive firing trials of actual XM16E1s, which in any case did not yet exist in quantity. In fact, the *only* test of the rifle and new ammunition as a *system* had been the fouling test run concurrently with the barrel erosion portion of Frankford's alternate powder trials themselves, wherein 6,000 rounds from each of the four test lots had been fired from each of two new, clean AR-15s. No stoppages or malfunctions had been reported as attributable to any of the four propellants.

Perhaps the air of "whiz kid" confidence exhibited by Gene Stoner's disciples in OSD had been shaken somewhat by Frankford's discoveries of inherent design faults in the "fully-developed" .223 round. In any event Stoner, who was by this time employed by Cadillac Gage and attempting to interest the Army in the Stoner system, had not been consulted about the M193 primer and propellant modifications. When advised of them he was deeply concerned that, regardless of the pros and cons, the changes had been made without first ensuring their long-run compatibility with real rifles.

Testifying later before the Ichord subcommittee, Stoner told of a meeting which had taken place during the summer of 1964 with the TCC's Frank Vee, of the OSD's Comptroller's office:

..he asked me my opinion after the fact. In other words, this was rather an odd meeting. He asked me to meet him and I did, and I looked at the [new] technical data package and he said, what is your opinion, and I said, I would advise against it, because...All of our experience was with the other cartridge, with the other propellant, and I [don't] quite see changing..without an awful lot of testing before..

I asked, so what is going to happen, and he said, well, they already decided this is the way they are going to go..

I said, so why are you asking me now, and he said, "I would have felt better if you had approved the package."

And I said, well, now we both don't feel so good.

Regarding the change in primer sensitivity, Stoner went on:

..We had another thing that happened on the Marine Corps test...We had some inadvertent firings of the weapon due to the primer...We were using a commercial primer..which is relatively soft and sensitive, and the Marines..would single-load the weapon. They would put a round in the chamber and let the bolt go home by pushing the..bolt catch, and the inertia of the firing pin would fire the weapon sometimes..

It was a very low frequency, but it did happen. So, of course, they wanted something done about it, and..there were a couple of solutions. Either desensitize the primer, make it out of a thick material, or lighten up the firing pin...I recommended..lightening up the firing pin because..if you desensitized the primer too much it could cause failures to fire in the field [which ironically did happen, especially in Stoner machine guns].

And..in this technical data package they decreased the sensitivity of the primer at the same time they..put the ball propellant in. So these were the two things I objected to..

As far as OSD was concerned, the all's-well-that-ends-well outcome to the chamber pressure problem, accomplished without any degradation in the M193's muzzle velocity and hence lethality, was hailed as a victory. Furthermore, the approval of two sources of propellant meant that for the first time the program was in conformance with the Army's stated policy of always having more than one powder approved for a given cartridge, in the event of a military emergency or hitch in

production. Generally speaking, in any procurement situation the Army tried to avoid what was known as a "sole source" relationship, except, of course, where regulations forbade it, such as in the case of a "one-time buy".

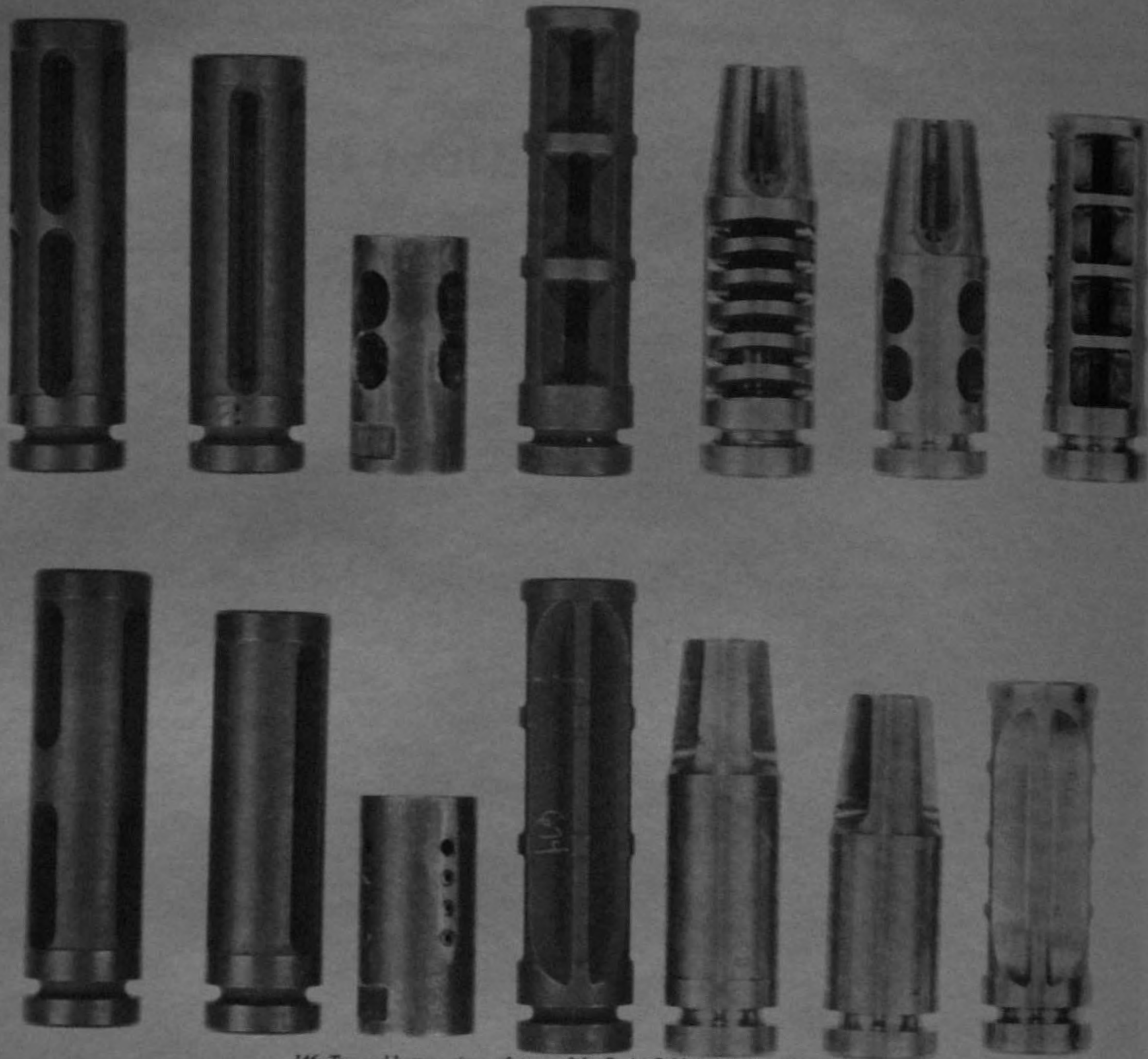
The First M16 and XM16E1 Deliveries

145. The Army's first XM16E1s, being inspected at Colt's before being delivered in March of 1964.

Despite warnings from Gene Stoner and Frankford Arsenal that more testing was needed, the first M193 ammunition production crisis was declared successfully surmounted, and not a moment too soon: the rifles were arriving. Lt. Col. Yount's significant action report for the week of 9-13 March 1964 records that 20 XM16E1s had been delivered to TECOM for use in a comparison test with first-generation SPIW prototypes. In conjunction with their ongoing combat effectiveness trial of various "muzzle brake compensators", TECOM had requested that five of the 20 XM16E1s be equipped with the latest compensator design from Springfield Armory, plus Colt's newly-developed two-round-burst device. A second five rifles were fitted with the muzzle brake/compensator only, and the remaining ten were supplied as is, "with no added devices".

The first true M16, meaning the first rifle procured for the Air Force under the combined four-Service "one-time buy" (contract "508"), was presented by Colt's to USAF Major General E. J. Gibson at a ceremony at the historic Hartford plant on March 30. The next day the Air Force took delivery, on schedule, of their first lot of 300 rifles and concurrent spare parts. By early May, the PMR was able to report that "..cumulative acceptances are now 1,800 rifles with applicable spare parts, which equals contract schedule through April."

As for the XM16E1, the significant action report for the week of 25-29 May 1964 recorded:



146. Top and bottom views of some of the Springfield Armory experimental muzzle brake/compensators being tested by TECOM in early 1964, in conjunction with the newly-arrived XM16E1s. *Springfield Armory NHS*

147. Top and bottom views of yet another Springfield Armory experimental muzzle brake/compensator. *Bob Miller collection, photo by Roy Arnold*

A specially furnished XM16E1 rifle representing the first rifle for Army under the FY64 contract was presented to General Wheeler [the Army's Chief of Staff] in his office on 26 May..by Mr. Paul Benke, President of Colt's. The new developments by Colt's, which are related to the AR-15 rifle, were also shown to General Wheeler. He showed special interest in the Colt developed 40mm grenade launcher and stated that the Army had a definite requirement for such an item.

(This first news of "new developments by Colt's" refers to the CAR-15 and CMG-1 weapons systems, discussed in chapter 11. The idea of an auxiliary grenade launcher for the M16 was an interesting offshoot of the SPIW program, and is further discussed in chapter 15).

By the end of May the Army had accepted the first 200 XM16E1s, and deliveries of new rifles to both the Army (XM16E1s, with bolt closers) and the Air Force (M16s) was on schedule in accordance with the contract.

The Hard Way Part 2 - The Cyclic Rate Problem

Meanwhile, it transpired that some of the ammunition loaded for the Air Force with WC846 ball powder, mentioned earlier in Olin's letter to AMC, had been routinely shipped to Colt's to be used along with existing stockpiles loaded with IMR4475, in support of ongoing XM16E1 acceptance tests. The following Minutes of the TCC's proceedings, which significantly did not merit mention in the PMR's weekly action report for this period, were later read into the record of the Ichord subcommittee hearings:

148. A one-piece, molded plastic buttgroup-and-lower receiver unit, one of many experimental "what-if?" one-offs which Colt's has produced over the years of the M16 program. This one didn't stand up satisfactorily to military tests.

At the meeting of 24-25 March 1964, Colt's..reported that not all weapons could meet the cyclic-rate requirement of 650 to 850 rounds per minute. In a sample of 10 rifles tested by Colt's with two lots of ammunition, six rifles exceeded 850 [rpm] when fired with ball-propellant ammunition, and one rifle exceeded this limit when fired with..IMR propellant. Colt's stated that the initial delivery of 300 weapons..had been selected (from a larger number of weapons available) so as to deliver only weapons which met the prescribed cyclic rate. However, this selection process could obviously not continue, since deliveries could not be made if a large fraction of the rifles were to be rejected for exceeding 850 [rpm]. Colt's asked for an increase in the upper limit of cyclic rate to 900 rounds per minute.

No increase in allowable malfunctions was requested..at this time, because it was not recognized that an increase in cyclic rate from 850..to 900 [rpm] would cause an increase in frequency of malfunctions.

Bill Davis comments on the inevitability of this cyclic rate variation, given the alteration of other parameters in the chain:

..it is an elementary principle that, if the area under the pressure-travel curve of the bullet (which governs the muzzle velocity) must remain the same, while the maximum ordinate (peak pressure) of that curve must be reduced, the ordinates (pressures) at other points under the curve manifestly must be increased. Whether the port pressure, which affects the cyclic rate of fire, would be intolerably increased could not be foreseen, because there was, quite astonishingly, no information whatsoever available on the limits of port pressure at which the AR-15 was designed to operate. [We] found, to our great surprise, that neither Stoner, nor ArmaLite, nor Colt's, nor Remington, nor ARPA, nor anyone else had ever measured the port pressure of .223 ammunition, or given any consideration of its effect on cyclic rate..

The cyclic rate problem erupted so quickly that the TCC was forced to grant a temporary waiver allowing the higher rate: the only other choice was to halt the program and face Colt's with the news that 6 out of every 10 of their new XM16E1s were unacceptable to the Army, due simply to the propellant being used in the test ammunition.

Accordingly, Colt's was granted a 50-rpm waiver on the upper cyclic rate limit, effective with April's production run. This allowed the government's in-house inspectors to accept XM16E1 rifles firing as high as 900 rpm. (The problem did not apply so much to the Air Force, who had already set the M16's acceptable upper cyclic rate limit at 900 rpm.) The TCC doled out the waiver on a month-to-month basis throughout the summer of 1964, thereby buying themselves some time to assess the powder-related cyclic rate phenomenon.

Meanwhile, with only the TCC's month-to-month waiver holding the XM16E1 production program together, Colt's had naturally wanted some fast and significantly *independent* answers to help them assess their position. On April 17, Colt's Senior Product Engineer F. E. Sturtevant submitted an internal

company report entitled *Chamber and Gas Port Pressures - Ball Powder vs. IMR Powder,* wherein were recorded the results, by the prestigious H. P. White Laboratories, of an examination of the first shipment Colt's had received of cartridges containing WC846 powder. The study found that the ball powder produced gas port pressures in the neighborhood of 500 psi higher than the original IMR4475, and

..Quite obviously, the port pressure is higher with the ball powder than with the IMR..used in all .223 cartridges previously..

In my opinion, the slightly higher port pressure of the ball powder is in no way harmful to the AR-15 rifle. The

In the light of future events, not only was Mr. Sturtevant's opinion wrong, but his last words were exceedingly ill-chosen.

that it delivered more heat to the gas tube. The report noted that Frankford had recorded the same higher port pressures in its 1963 alternate propellant study, which Mr. Sturtevant confirmed as "the first known measurements of port pressure, so far as I know".

The Colt internal report concluded:

slightly increased energy imparted to the bolt carrier, may make certain a full stroke and impact on the end of the receiver extension. This does not always occur with the present ammunition. Such increased stroke will improve the functioning of the bolt catch as well as assist in a quicker "break in" of the rifle.

As the problems multiplied, despite Colt's assurances, Frankford's message to the TCC grew sharper:

Frankford Arsenal

Eleventh Memo Report on AR-15 Rifle/Ammunition System

Investigation of Port-Pressure Limits

12 June 1964

Introduction

..It was pointed out [in the fourth memo report "Investigation of Gas-Port Pressures in .223 Ammunition" dated 19 June 1963] that gas-port pressure is undoubtedly an important parameter of ammunition design for the AR-15 (M16-type) rifle, and ought to be controlled. As the lots [of commercial .223 ammunition, loaded with IMR4475] tested had reportedly been satisfactory..and their port pressures were observed to be typically near 15,000 psi, limits were recommended tentatively and somewhat arbitrarily at 15,000 +/- 2,000 psi. This range of pressures, based originally on engineering judgement and very little direct evidence, has in subsequent experience proven reasonably consistent with.. acceptable functioning and ..ballistics...However, as was pointed out..a definitive and specific testing program is required to establish the port-pressure limits which the.. weapon can tolerate without serious impairment of functioning or durability.

Observations

..cyclic rate depends heavily upon port pressure at very low..levels, but the degree of dependency diminishes with increasing level of port pressure...At levels above the present minimum..(13,000 psi), the cyclic rate does not change very drastically, and it appears that the change is not significant above 14,000 or 15,000 psi.

Insofar as the two..rifles [serial nos. 033042 and 034729] used in the test are representative of the type, the cyclic rates..with ammunition having normal port pressure are somewhat higher than the typical value (750 rpm) implied by the rifle-acceptance criteria. In the Minutes of the [TCC] Meeting of 24-25 March..it is stated that the Army acceptance criteria..are 650-850 rpm, and the USAF criteria allow an upper limit of 900 rpm..

As regards the upper limit for acceptable cyclic rate, it appears that 850 rpm may frequently be exceeded, and that

900 rpm may be exceeded at least occasionally with certain clean, well lubricated weapons, when using normal ammunition lots having port pressure above 14,000 psi. Whether or not cyclic rates above 850 rpm (or 900 rpm) are disadvantageous cannot be established from this experiment. If such rates are disadvantageous, then some modification of the weapon seems necessary to diminish its cyclic rate when firing normal ammunition. If such rates are not disadvantageous, the re-examination of the upper-limit criteria for rifle acceptance seems necessary.

As regards minimum..criteria for loading, this limited experiment demonstrates..that port pressures below about 10,000 psi must be avoided...As regards maximum tolerable port pressure, this test gives no basis for judgement..

..the maximum port pressure attainable with a case-capacity charge [of WC846] was about 16,200 psi...This test gives no indication that port pressures up to 17,000 psi would impair the reliability of weapon functioning. Any disadvantage..would seem to depend on whether the endurance of the weapon is significantly impaired in consequence of greater energy of recoiling parts. Kinematic records of the bolt in recoil would yield some useful data..as would also of course the results of extended endurance testing. However, such tests of the weapon are beyond the scope of this effort and of this report.

..In the final analysis, the tests required to establish tolerable port-pressure limits for the AR-15 are weapon tests..

As noted, Frankford Arsenal had already begun to record AR-15 gas port pressures before the emergence of the cyclic rate problem. Unfortunately, however, in the absence of any weapon-endurance tests or at least a thorough kinematic analysis of the M16's recoiling parts when subjected to the higher cyclic rates being produced by ball propellant, there was no way of determining the long-term effects of higher port pressures. In more or less secret defiance of the Gilpatrick directive, both Springfield and Frankford were doing what they could, the latter facility having designed and built an "unofficial" port pressure gauge as early as June of 1963. However, throughout this crucial period of ammunition changes and early rifle deliveries, no such testing was officially funded.

The Hard Way Part 3 - The USAF Plate Penetration Problem

In the midst of these initial port pressure/cyclic rate investigations, it suddenly appeared that Olin had spoken too soon in declaring that the Air Force had already accepted ball-powder M193 ammunition. Lt. Col. Yount's significant action report of 20-24 April heralded yet another unforeseen result of the switch in propellants:

Initial production sample of cartridge, 5.56mm, M193, tested and submitted by Olin Mathieson against the USAF requirement..has been rejected by the government at the contractor's plant since it failed to meet the [Air Force's 500-yard] plate penetration requirement..

At the option of the contractor this ammunition was shipped to Frankford Arsenal on 16 April for final pre-production lot testing. Frankford..was verbally informed by Ogden Air Material Area that the deviation would not be approved by the USAF.

For some background on this latest problem, the TCC turned to Frankford's fifth memo report on the AR-15 rifle/ammunition system, dated September 1963, wherein the long-suffering Arsenal staff had already discovered that the Air Force's plate penetration requirement was apparently more traditional than practical:

..A plate penetration requirement was contained originally in specification MIL-C-9963 (USAF) dated 24 January 1963 entitled: "Cartridge, 5.64 millimeter Ball MLU-26/P." This.. was as follows:

"3.13 Penetration. The bullet..shall pass completely through 10 gauge (.135 in.) mild steel plate (SAE 1010-1020 with a hardness of Rockwell B55 to B90) at a range of 500 yds."

The plate-penetration requirement has been included in the specification for 5.56mm (.223) probably because of the precedent of a similar inclusion in specifications for 7.62mm M80 ammunition...In retrospect, it appears doubtful that

[it] is justified. The weight, materials, construction, shape, and instrumental velocity of the bullet are stipulated within rather close limits..and these parameters essentially imply the penetration characteristics within rather close limits also. Within these other stipulated parameters, there is very little latitude for adjustment by means of which the ..manufacturer could affect the plate-penetration characteristics, [which] are..largely implicit in the cartridge design, and superfluous as a criterion for acceptance of ammunition..

Ending with another plug for the more-lethal "Type B" bullet, the Frankford report concluded that, within the rigid specifications the TCC had already set, the bullet's penetration performance *per se* was essentially beyond any manufacturers' control. Since all the bullets tested would consistently penetrate the 10-gauge plate at 450 yards, the recommendation was that the Air Force "re-evaluate" its 500-yard requirement.

Accordingly, after some further face-saving penetration tests run jointly with the Army at Frankford, the Air Force reduced its plate penetration requirement to 450 yards. The PMR's significant action report for the week of 1-5 June, 1964 records that Olin's pre-production engineering sample of M193 ball ammunition "passed the revised Air Force penetration requirement...Initial delivery in the month of June is anticipated in accordance with the contract."

Tense Times for the TCC

Frankford continued to urge the initiation of some solid, long-term test program with M16/XM16E1 rifles and M193 ammunition as a *system*; previously a normal and very necessary part of any Ordnance-sponsored small arms program. However, the Gilpatrick directive had specifically directed the TCC to avoid the "cost, delay and..difficulties" of acceptance test standards in procuring the "fully-developed" AR-15/M16 system.

Thus the sad fact was that the TCC was forced to wear blinkers, not to say blindfolds, and became increasingly enmeshed in the "crisis management" of problems which could not possibly be foreseen or heralded, but which simply erupted with no warning.

Chapter Ten

THE FURTHER ADVENTURES OF THE TCC

Thus the weapon/ammuniton system comprising the M16/XM16E1 rifle firing M193 ball ammunition now differed in several significant respects from the erstwhile "fully developed" AR-15 firing Remington .223 cartridges loaded with IMR4475 propellant, commercial primers and "Type B" bullets. In addition, as noted, the allowable "leeway" between the average and maximum chamber pressure limits in M193 ammunition was *much* narrower than usual for a mass-produced military small arms cartridge.

XM16E1s first became available for issue during the spring of 1964. By May 8 the PMR had recorded cumulative acceptances of 1,800 rifles. Meanwhile, steps had been taken to begin the procurement of all the ancillaries, accessories and training aids necessary to support the issue of the new system. Here too the TCC were forced to comply with OSD, where Colt's assertions that the AR-15 needed minimal maintenance still held sway. Directed to keep the program as simple and inexpensive as possible, the TCC turned in a disastrously poor track record as "housekeepers", especially with regard to cleaning equipment and maintenance instructions for the XM16E1. Nevertheless, to continue the space analogy concerning the M16's "universe", the program had successfully "lifted off", problems and all, with the TCC as the crew but with OSD at the controls.

With the rifle and cartridge designs finally locked up and in production, Secretary McNamara's attention was soon drawn elsewhere. The M16/XM16E1 rifle and the M193 cartridge were now supply items, and as such fell back into the purview of Lt. Col. Yount's patron, General Frank S. Besson. Surely one of the busiest men in the Pentagon, the Commanding General of the entire Army Materiel Command (AMC) had a great deal more on his plate than just the one-time procurement of a paltry few thousand rifles. Increasingly, however, General Besson was obliged to lend his considerable weight to the faltering M16 project, in order to keep it from sagging seriously off course.

It began innocently enough in May 1964, when the Project Manager's weekly significant action reports began carrying a section headed "Continuing Problems". The TCC had formed a "New Materiel Introductory Team" to introduce the new rifles to the special troop units for whom they had been procured. As part of the presentation, the team wanted to include a five- to seven-minute tactical briefing on the use of the M16 in the field. A debate had dragged on throughout the month with both CONARC and the Combat Developments Command (CDC) stubbornly disclaiming responsibility for the preparation of such a document. In the process, for all his special powers, the PMR was reduced to the role of hapless observer. The first of many curt notes in General Besson's peremptory handwriting is scrawled across his copy of the action report for the week of May 18-22, reading: "Whose job do *we* think it is?...I still believe tactical employment (doctrine) is CDC business, but I don't propose to make an issue of it...[Go and] get a proper source designated."

In early June, amid news that the Federal Cartridge Company had defaulted on its first 200,000-round M193 ammunition contract, the PMR reported that work has been stopped on the development of blank ammunition and a BFA (blank firing adapter) for troop training, because "no RDT&E funds are currently authorized for this project...Since the blank round and BFA are considered a joint development for technical reasons, the delay of the BFA..also causes a delay in the blank round.." General Besson's blunt pencil cuts impatiently through the bureaucratic fog: "It is ridiculous to buy 80,000 rifles and not get the necessary accessories. Get this off dead center - let me know if you can't get an early decision."

A Most Contentious Waiver

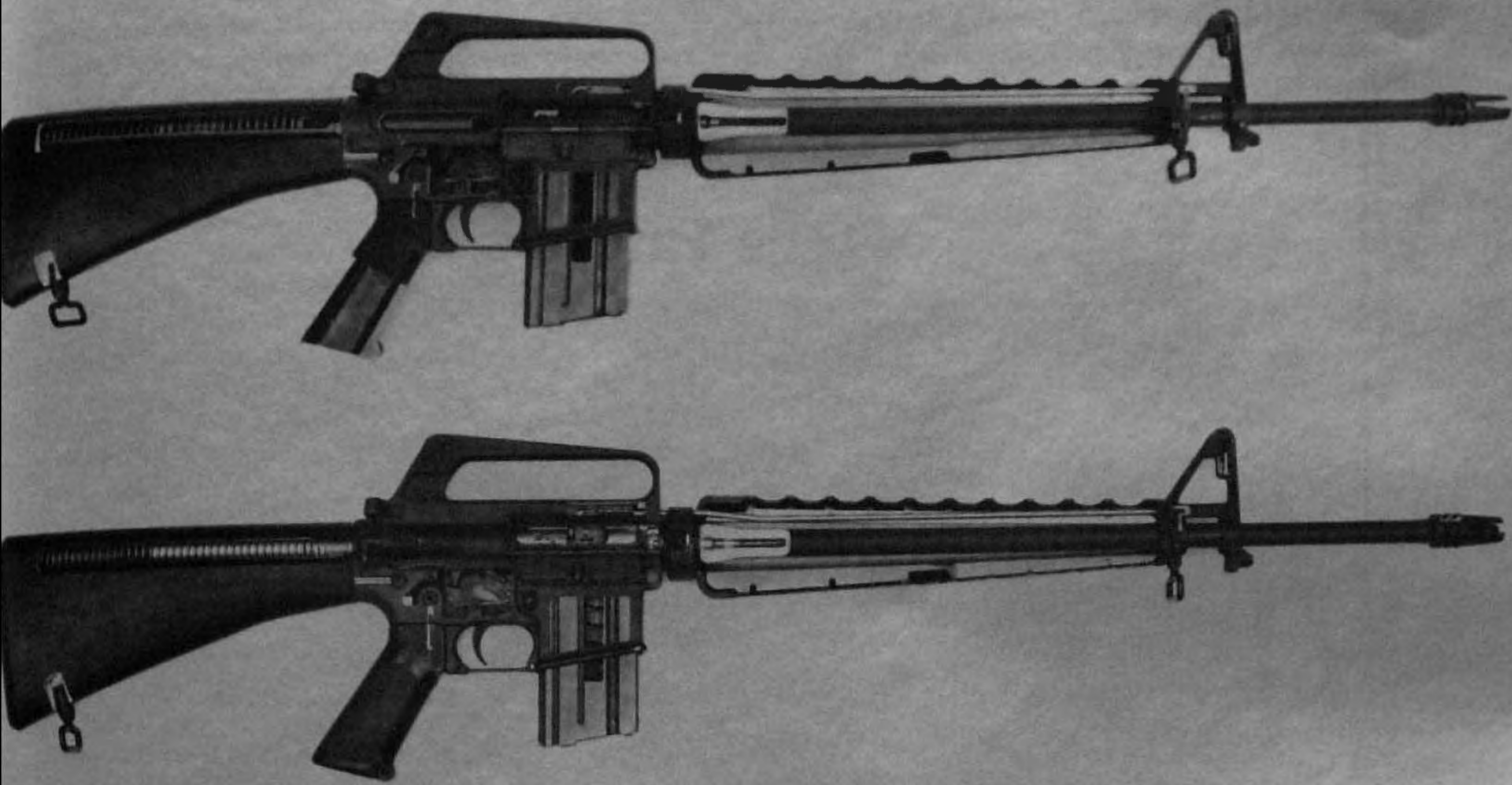
In the week of 3-7 August, with Colt's delivering XM16E1s on schedule, General Besson again revealed his concern for the state of the M16 program by pencilling across the PMR's neatly typed production figures, "How many [rifles] are in

149. A proud Special Forces trooper in the spring of 1964, displaying his brand-new XM16E1.

the hands of troops and what are we doing to follow up on troop experience?'' Lt. Col. Yount did not reply, but he did do something else that month which somehow didn't rate mention in his significant action reports.

It will be remembered that, ever since the first delivery of ball-powder test cartridges to Colt's in April and the subsequent eruption of the cyclic rate problem, XM16E1s had been produced under a month-to-month, 50-rpm waiver on the Army's upper cyclic rate limit. Even though the Air Force had already set their upper limit at 900 rpm and to date were reporting no problems, the TCC had refused to grant Colt's request for a standing cyclic rate waiver on the Army's XM16E1s. The main duty of the Project Manager Rifles, the expedited supply of XM16E1 rifles to the field, was thus on shaky ground indeed.

The concept of waivers — of knowingly degrading some parameter of a system in order to proceed with production — is utilized literally hundreds of times over the full course of a typical military procurement program. In order to ensure



150. Above: a Colt factory "cutaway" of an AR-15 (XM16E1) model 02. Compare with fig. 130. *Bob Miller collection, photo by Roy Arnold*
Below: a later (XM16E1) cutaway with bolt closure device.

XM16E1 deliveries, the Project Manager gambled that the increased cyclic rate produced by the ball powder in the "preponderance" of the ammunition already in the field was indeed only a technical problem. As soon as cartridges loaded with DuPont's CR8136 became available from Remington in August, he ordered a quantity of them shipped to Colt's, exclusively for use in XM16E1 acceptance testing. As Frankford had noted, one characteristic of CR8136 was that it produced consistently lower port pressures (by about 800 psi) than did WC846. Sure enough at Colt's, the cyclic rates dropped back into the 650-850 slot. The month-by-month 900 rpm waiver was thereupon quietly allowed to expire.

The One-Time Buy that "Grew Like Topsy"

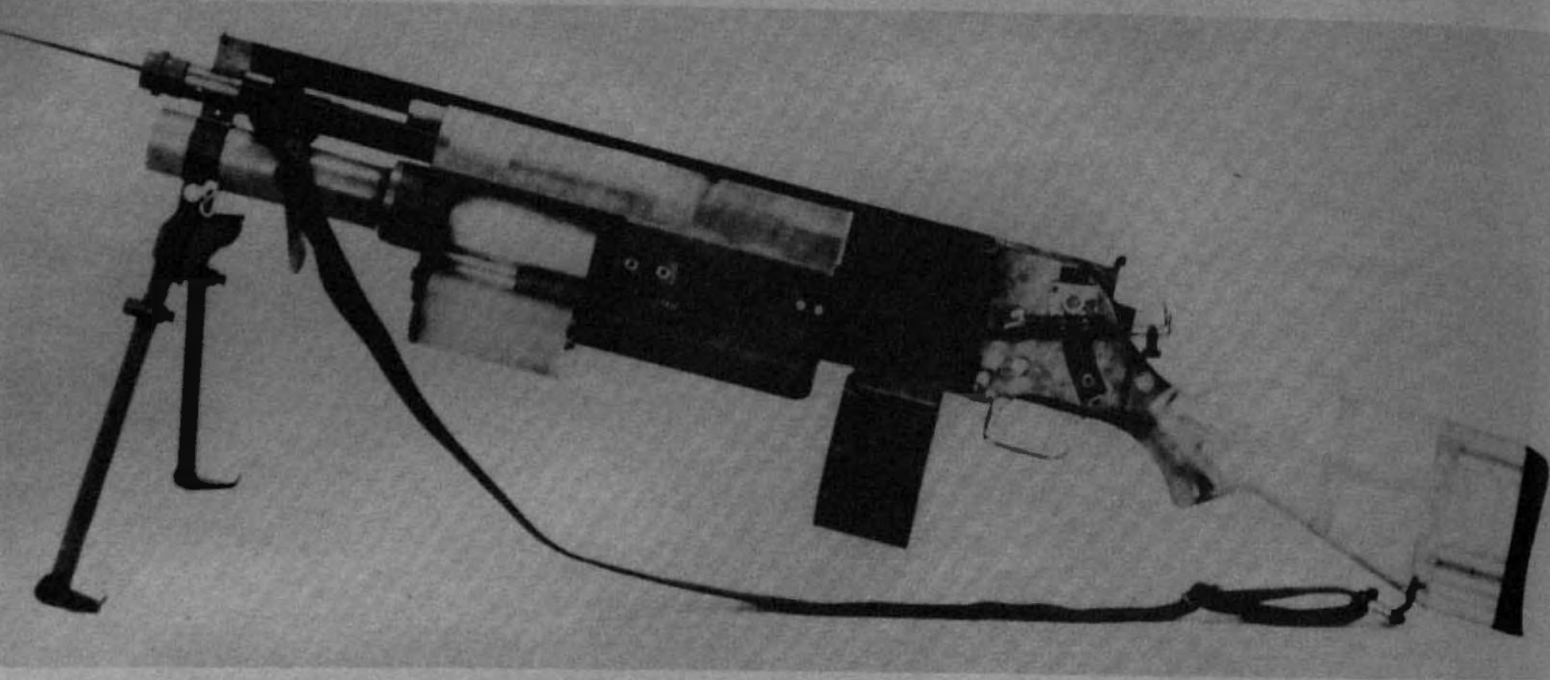
Throughout the summer of 1964, with the TCC's XM16E1 Introductory Team being greeted "with great enthusiasm" in Germany and France as well as at home, the complexity and size of the FY64 procurement contract grew steadily. (For the week of August 31 - September 4, the PMR had noted "Based on an urgent special requirement, 600 rifles from August production were diverted to the Far East.") On October 30, when Colt's again advised that they were nearing the end of production on the FY64 contract, the TCC saved the day by invoking the contract option clause for the seventeenth time, adding "33,500 M16 rifles for the Air Force, 240 M16 rifles for the Navy and 82 M16 rifles for the Coast Guard, and $517,000 worth of spare parts." This hiked the original $13.5 million contract with Colt's to $17,994,694.23.

First Troop Reports

General Besson had continued to press for the earliest possible troop reaction to the new rifles. The 5th Special Forces Airborne Group of the 1st Special Forces at Fort Bragg had submitted the first-ever monthly field report on their new XM16E1s, dated September 4th. Gauges, tools, manuals and rifle racks were listed as being "in short supply",

and the initial issue of "Rod, Cleaning, M11" was immediately singled out as being too flimsy and easily broken, even in normal use. Other than that, on the whole the new rifles appeared to have been very favorably received. One Special Forces suggestion, which went unheeded by the TCC at great later expense, recommended that "some type brush be adopted to clean the space between the bolt locking lugs and chamber, in barrel extension."

The Patsy



151. The 23.9-lb. Harrington & Richardson SPIW, designed to fire three flechettes with each shot from the Dardick "5.6x57mm triple-bore Tround". Aside from missing the ten-pound weight limit by a considerable margin, the ungainly H&R SPIW was dismissed upon initial examination as unsafe to shoot.

152 The Olin (Winchester) SPIW, chambered for the XM144 flechette cartridge (fig. 153). Note the three-shot, "blow-forward" grenade launcher, later adapted to the second-generation Springfield SPIW (fig. 217). Winchester-Western Research Department photo

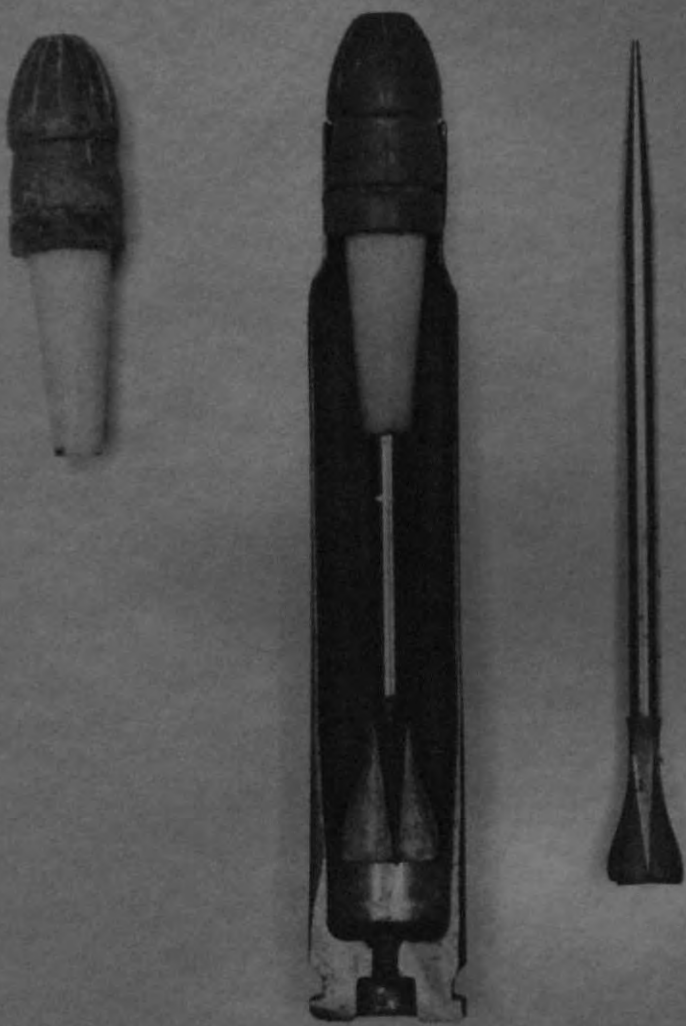
As related in detail in ***The SPIW***, the "phase I" SPIW weapon and flechette ammunition trials at Aberdeen and Fort Benning had been running concurrently with the events described above, from April 1964 to the middle of August. The SPIW master plan still called for the successful candidate SPIW system to be type classified Standard 'A' by June 30, 1965. Unsettlingly, however, the results of "phase I" ranged from the abysmally poor (H&R) through varying degrees of unsatisfactory (Winchester; Springfield; AAI).

Paradoxically the latter two, which at length were chosen for further development, already worked well enough, when

they worked at all, to exhibit some truly bizarre characteristics. Indeed, to anyone versed in firearms, witnessing the awesome (if sporadic) phenomenon of the ungainly 1964 SPIWs in action, the handwriting was clearly on the wall: perfecting the SPIW as a viable military weapon system would require a development program orders of magnitude beyond anything ever previously attempted.

However, the official attitude was unfortunately one of "unwarranted optimism" that the SPIW could quickly be brought to fruition. At a meeting between General Besson and the Commanding General of Rock Island Arsenal, Roland B. Anderson, the matter was taken under advisement. Finally, it was decided: who better to put the program back on its feet and oversee the SPIW through to Standard 'A' status than the man who was doing such a good job with the AR-15?

Lt. Col. Yount's title was still, officially, "Project Manager, AR-15". On October 7, with all the gravity befitting the situation, it was formally changed to "Project Manager, Rifles". Along with the slight change in title came an expanded new charter of duties, which included complete responsibility for the already dubious future of the entire SPIW program.



153. Cutaway closeup view of the 5.56x44mm XM144 single flechette cartridge, developed at Frankford Arsenal for (smoothbore) fire from the first-generation Springfield and Winchester SPIWs and the short-lived "Universal Machine Gun" (designed by A. L. Montana and built, in prototype only, at Springfield Armory). Left: teflon-coated sabot assembly. Center: as loaded with the AAI standard flechette and sabot. Note the small primer pocket, for Frankford's special "Primer, Miniature, FA T186E1". Right: a practice "blunt" flechette. Antipersonnel flechettes were carefully ground to a very fine point.

154. Springfield Armory (14.5-lb.) first-generation SPIW. In the words of its designer, the adamant requirement for a 10-lb. weapon carrying 60 point-target flechettes plus three 40mm grenades made the SPIW "the first of the programs to be doomed from the start by ridiculous specifications".

Springfield Armory photo dated March 30, 1965

155. The AAI Corporation's first-generation SPIW, chambered for the 5.6x53mm AAI XM110 flechette round (muzzle velocity 4,820 fps; chamber pressure 69,000 psi). This early 5-lb. (point-target version only) AAI SPIW fired 2,400 rpm three-round bursts from a 60-round drum magazine.

Keeping Colt's Honest

Also concurrent with the first issue of the M16/XM16E1 and the phase I SPIW trials, Aberdeen had begun an ongoing program sponsored by AWC, of performing the standard series of light rifle tests on production rifles from Colt's. An extrapolation from George Hendricks' final report of trials of five new M16s using M193 ammunition made by Remington (lot RA 5027, loaded with CR8136 propellant) reveals the following:

Rifle ser. no.	Total number of rounds fired
040048	1,457
040219	2,708
040250	1,465
040284	6,020
040297	6,602
	18,252

Interestingly, no XM16E1s were featured, possibly because at the time of these tests there was no Army Technical manual in existence for the XM16E1. The D&PS test officers were accordingly supplied with a copy of the USAF TO 11W3-5-5-1 "for interim use". Excerpts from the report are as follows:

In the [600-round] rain test, 13 failures to fire occurred [all in the last 100 rounds]. Several pieces of brass from a punched-out primer lodged on the firing pin and caused the malfunctions.

After being subjected to +125°F and 90% relative humidity for approximately 18 hours, the cam pin rusted and caused extreme difficulty in opening the bolt..

Conclusions

It is concluded that:

With the exception of one rifle which failed to meet performance specifications because of excessive failures to fire semiautomatically, all of the rifles tested met those performance requirements outlined in SAPD-253..

In the automatic accuracy and adverse conditions testing (no performance criterea delineated in SAPD-253) no significant design or operational deficiencies were encountered..

Recommendations

It is recommended that:

Consideration be given to excluding the 5-round-burst automatic-accuracy firing from the standing position from future comparison test plans..

Adequate cleaning equipment..accompany the rifles.

Consideration be given to incorporating into SAPD-253 lubrication requirements for the rifles as described [above].

A total of only 18,000 rounds fired (all from the same manufacturer) was hardly the sort of exhaustive testing Frankford was urging, but it sufficed to highlight the fact that the M16 rifle needed thorough cleaning at least every 1,000 rounds in order to function reliably.

Unfortunately, however, despite Aberdeen's reinforcement of the Special Forces' earlier request for such specific items as chamber brushes, the TCC continued to ignore the whole issue of adequate maintenance equipment for the M16/XM16E1. This state of affairs was severely compounded by the events discussed below.

The Hard Way Part 4 - Sole Source with Ball Powder

In December 1964, Remington again advised the Army of their inability to stay within the average upper chamber pressure limit when loading M193 ball ammunition. Even though CR8136 propellant more consistently conformed to specifications than had IMR4475, DuPont had found that they could not guarantee chamber pressures within the tight average upper limit in lot-to-lot production. Consequently, CR8136 too was being withdrawn. Remington requested that they be allowed to continue loading in response to their contract, but with WC846 ball powder they would obtain from Olin's powdermaking plant in East Alton, Illinois. The TCC agreed to this proposal.

With all three cartridge manufacturers thus loading M193 ammunition with Olin WC846, the TCC was ironically right back to the sole source position on propellant which it had so recently and triumphantly overcome in the case of DuPont's original IMR4475. The only differences were that WC846 was known to cause higher gas-port pressures and cyclic rates in M16 rifles, and also seemed to contribute more fouling. As yet, none of these anomalies had much weight of evidence attached to it.

Despite the fact that *all* M193 ammunition produced for the field was now loaded with WC846 ball powder, XM16E1 acceptance testing continued at Colt's with stockpiled Remington cartridges loaded with CR8136, until these ran out in the spring of 1965.

Gene Stoner had meanwhile not been idle. Indeed, innovative designs of his were the source of some fairly constant competition to the M16 over the whole course of the program. Significantly, Stoner's originals were all in 7.62 NATO caliber: the AR-10; the AR-16, which he designed in the mid-fifties in cooperation with ArmaLite project engineer Arthur Miller; and the Stoner 62.

Interestingly, each of these was the source of an important 5.56mm "spinoff" wherein the original was scaled down by other engineers, generally with only a modicum of involvement by Stoner himself. First, as we have seen, the AR-10 became, at Fairchild's behest, the AR-15. Then, after Stoner's departure from ArmaLite, Arthur Miller became chief engineer there on a project to scale down the stamped-metal AR-16 into the 5.56mm AR-18. Finally the Stoner 62, which utilized lessons learned in all Stoner's earlier designs, was "projectized" by the Cadillac Gage Co. of Warren, Michigan, and redesigned by the erstwhile ArmaLite engineering team of L. James Sullivan and Robert Fremont into the 5.56mm Stoner 63 and 63A systems, expressly for the Marine Corps.

All these weapons were built around the multilugged Johnson/Stoner bolt, but with Stoner's patented gas system assigned to Colt's, the latter designs were perforce fitted with conventional piston-operated gas impingement systems.

ORDNANCE TANK-AUTOMOTIVE COMMAND

Mr. Hayes: 30 Nov

OCO, Gen Schomburg, objects to OTAC giving any publicity to the Fairchild rifle, recently sent us by Gen Devers.

The OTIT may play with it, but will not use it for display or demonstrations.

NELSON M. LYNDE, JR.

MAJOR GENERAL, U.S.A.

COMMANDING

158. Despite problems with their bulky M14s and the hype from ArmaLite, the Tank Command remained, officially, Not Interested in the AR-16. It appears that only three AR-16s were ever made.

159. The ArmaLite .223 caliber AR-18, right side view with stock folded. Designed by Arthur Miller after Stoner's departure from Armalite. Compare with fig. 157.

160. A 1964 USAF cold-weather trial of ArmaLite AR-18 serial no. 002. At this and other trials the AR-18 was judged "in an unfinished state of design". Photo credit: Larry Stevens

161. Gene Stoner's first design for Cadillac Gage Company, called the Stoner 62, pictured here in the "Standard Auto Rifle" mode. Caliber 7.62mm NATO.


Rear sight
BASIC COMPONENT GROUP
Trigger group
Receiver group
Butt stock
Magazine
Belt Feed Group
Heavy barrel
2
LIGHT MACHINE GUN Belt Fed
Bipod
Solenoid
4
FIXED MACHINE GUN

162. The 7.62 NATO Stoner 62, described in this early Cadillac Gage brochure as "The first complete Small Arms Weapons System". At Colt's, the versatile Stoner component system was seen as a serious threat to the limited-adoption XM16E1 (prompting the neck-and-neck development of Colt's multi-version CAR-15 and CMG-1 systems, discussed below). The short-lived Stoner 62 was soon superseded by the .223 caliber Stoner 63, designed for Cadillac Gage by Sullivan and Fremont. (figs 190-194).

163. On a mission against the Viet Cong: an American advisor armed with an M16 rifle (note the early steel magazine) and his small-statured ARVN unit, who carry US M1 Garands.
Wide World photo, courtesy Colt's Inc. Firearms Division

The Colt "CAR-15 and CMG-1 5.56mm Military Weapons System"

Colt's realized that, just as the AR-15 had so audaciously challenged the M14, other competitive weapons would threaten the M16/XM16E1's relatively vulnerable "toehold" of limited adoption. An extensive Colt research and development (R&D) program was therefore undertaken to diversify the basic AR-15 (M16), with a view to offering the military as many interesting and practical M16-type weapons as possible.

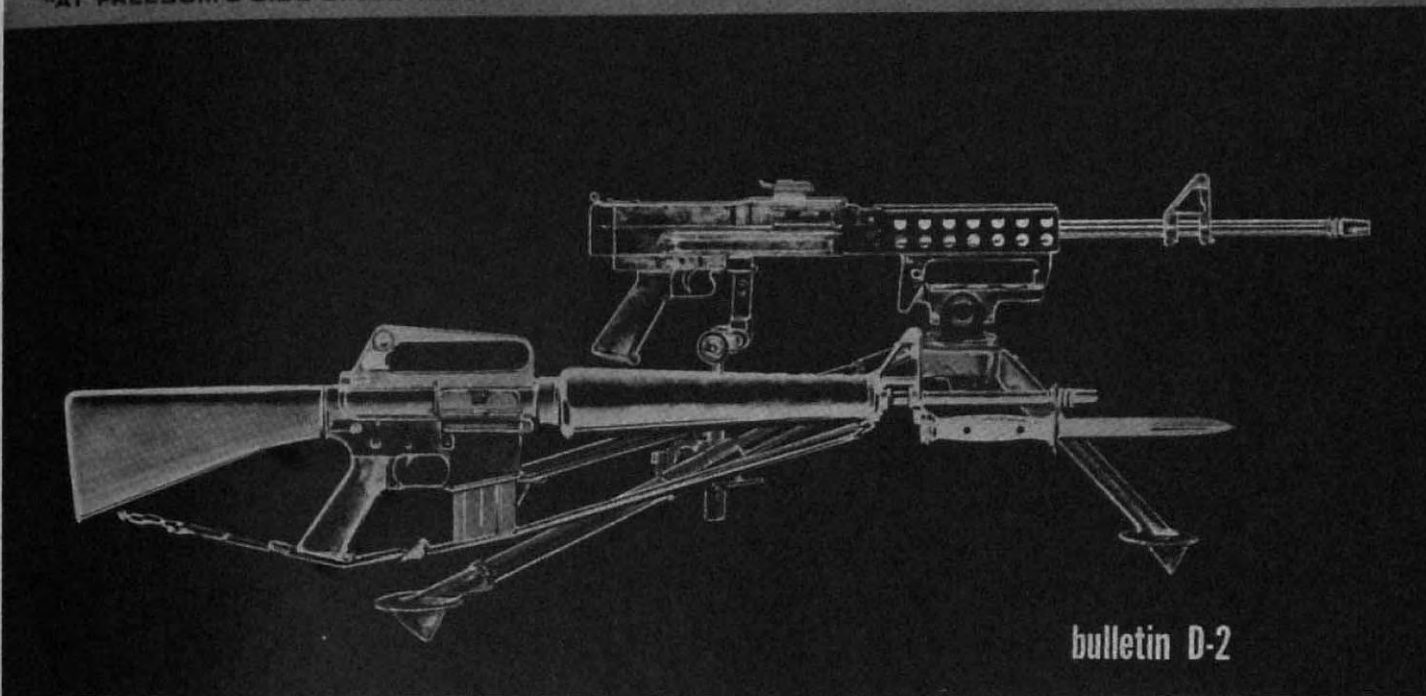
After trials with a few one-off "what-if?" models, Colt's focussed on seven basic versions of the M16: the standard M16 rifle, both as issued and also fitted with a Colt-developed 40mm grenade launcher attachment; a carbine with a 15" barrel; two heavy-barrel, bipod-supported "M-1" (clip fed) and "M-2" (belt fed) heavy assault rifles; a submachine gun with a 10" barrel and collapsible stock; and a no-frills survival rifle. In addition, in response to the threat presented by the versatile Stoner system, discussed below, Colt's hastily countered with four versions of a brand-new and extremely short-lived machine gun called the CMG-1.

Aside from limited purchases of 100 to 150 M-1 heavy assault rifles for trials during the upcoming SAWS program, the military was cool to most of Colt's CAR-15 Military Weapons System, and only a handful of carbines, M-2 belt-fed assault rifles and survival rifles were ever produced. However, the short-barreled submachine gun and the 40mm grenade launcher attachment did undergo considerable further development. These are discussed in detail in chapter 15.

COLT

5.56mm MILITARY WEAPONS SYSTEMS

"AT FREEDOM'S SIDE SINCE 1836"



164. First and second edition catalogs describing Colt's "CAR-15 and CMG-1, 5.56mm Military Weapons System". The lower "Second Edition" from May, 1965 was later described by a Colt designer as "very optimistic".

COLT

5.56mm MILITARY WEAPONS SYSTEMS

"AT FREEDOM'S SIDE SINCE 1836"

CAR-15 AND CMG-1 SPECIFICATIONS

SECOND EDITION
MAY 1965

Colt Industries
Colt's Firearms Division

COLT CAR-15 WEAPONS SYSTEM

COMMON COMPONENTS CHART *

Part Name	AR-15 (M-16)	Carbine	Heavy Assault Rifle M-1	Heavy Assault Rifle M-2	Sub-Machine Gun	Survival	XM-16E1
Lower Receiver	X	X	X			X	X
Bolt	X	X	X	X	X	X	X
Bolt Carrier	X	X	X		X	X	
Receiver Extension	X	X	X	X			X
Extractor	X	X	X	X	X	X	X
Upper Receiver	X	X	X		X	X	
Ejector	X	X	X	X	X	X	X
Barrel	X						X
Action Spring	X	X	X	X	X	X	X
Action Spring Guide	X	X	X	X	X	X	X
Magazine	X	X	X		X	X	X
Magazine Catch	X	X	X	X	X	X	X
Bolt Stop	X	X	X		X	X	X

Part Name	AR-15 (M-16)	Carbine	Heavy Assault Rifle M-1	Heavy Assault Rifle M-2	Sub-Machine Gun	Survival	XM-16E1
Disconnector	X	X	X	X	X	X	X
Front Sight	X	X			X	X	X
Rear Sight	X	X	X	X	X	X	X
Gas Tube	X	X	X	X			X
Automatic Sear	X	X	X	X	X	X	X
Hand Guard	X	X	X	X			X
Hammer	X	X	X	X	X	X	X
Pistol Grip	X	X	X	X			X
Trigger	X	X	X	X	X	X	X
Trigger Guard	X	X	X	X	X	X	X
Butt Stock	X	X	X	X			X
Charging Handle	X	X	X	X	X	X	X

* X's represent AR-15 parts used.

COLT CMG-1 WEAPONS SYSTEM

COMMON COMPONENTS CHART *

Part Name	Tripod	Bipod	Solenoid	Vehicle
Receiver	X	X	X	X
Barrel	X	X	X	X
Feed Cover	X	X	X	X
Feed Tray	X	X	X	X
Bolt	X	X	X	X
Bolt Carrier	X	X	X	X
Extractor	X	X	X	X
Ejector	X	X	X	X

Part Name	Tripod	Bipod	Solenoid	Vehicle
Pistol Grip Fire Control	X	X		X
Solenoid Fire Control			X	
Back Plate	X	X	X	X
Butt Stock	X **	X **		X
Action Spring	X	X	X	X
Charging Handle	X	X	X	X
Bipod	X **	X **		X
Tripod	X **	X **		X

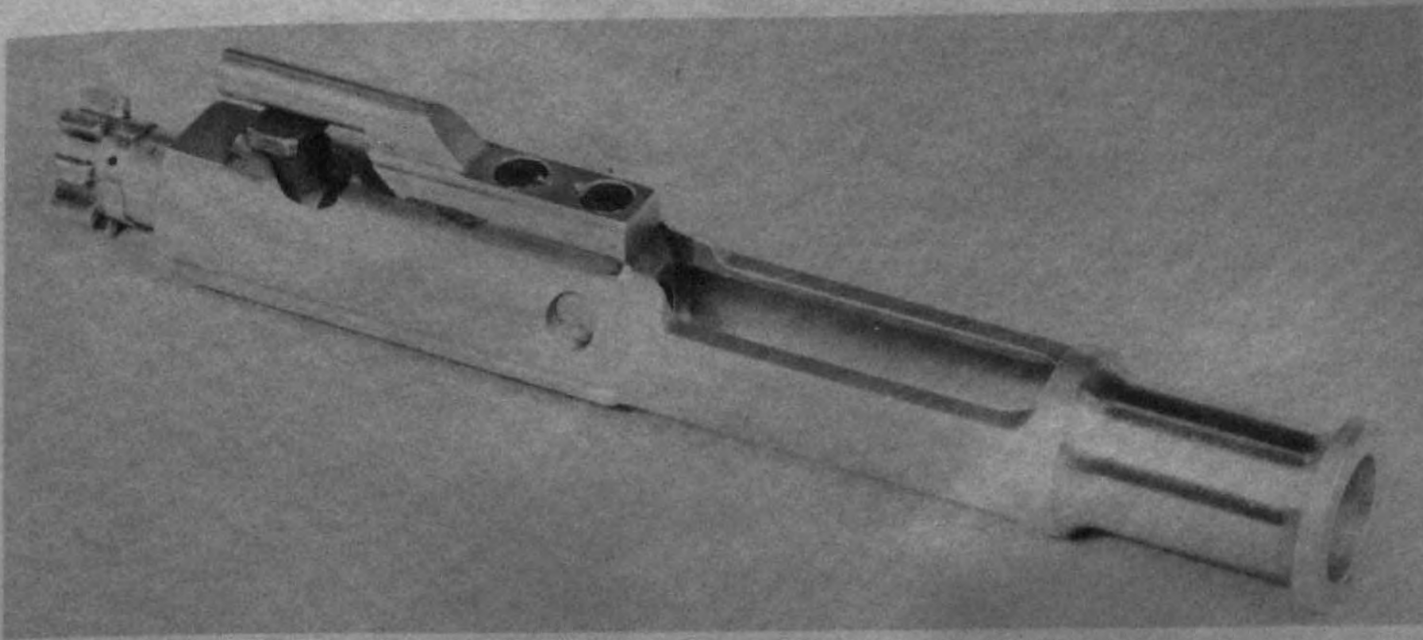
* X's represent common parts.

** Basic machine gun will accept bipod, tripod or butt stock.

165. Colt's Common Components Chart for the CAR-15 and CMG-1 systems.

The Colt CAR-15 Carbine

166. Factory prototype CAR-15 Carbine, with a shorter handguard, a 16" barrel and a modified, 4-position selector mechanism. Selector markings for AUTO and SEMI have been milled out, and now read AUTO up, SEMI rear, and "2 Shot" burst, down. Bob Miller collection, photo by Roy Arnold

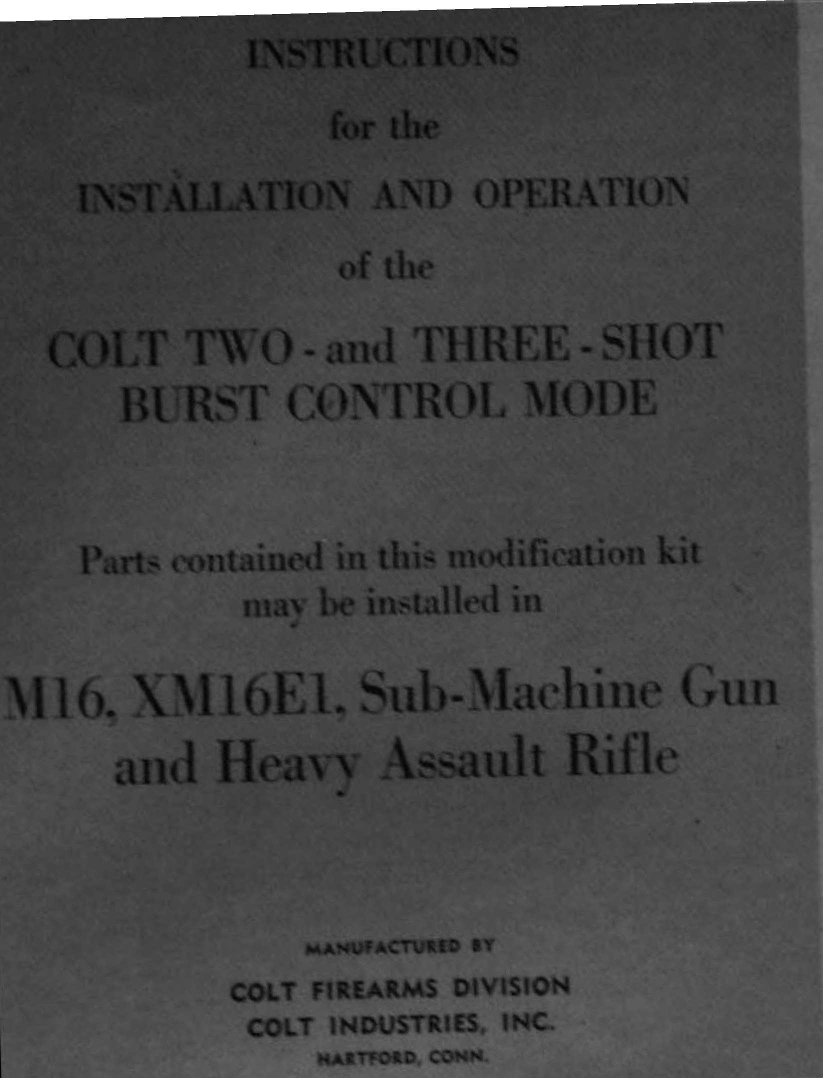


167. In developing the short-barreled Carbine and SMG versions of the CAR-15, Colt's soon discovered that shortening the handguard (and gas tube) required some "accommodation": the gas port diameter had to be opened right up to the same as the internal diameter of the gas tube itself (.110"); and this lightened "Bolt Carrier for Short Version" was produced and tested, both in "shorties" and heavy-barrel machine guns. Compare with fig. 182.

US Army Weapons Command photo dated August 6, 1964

168. Left and right side views of the official 15"-barreled CAR-15 Carbine, the Colt model (6)05B (Burst). As on the prototype (fig. 166) the change lever positions are reoriented (AUTO up and SEMI rear), but with down now marked BURST. The 34 1/4", 5.8-lb. Carbine was offered without success for use "where stowage is a problem, e. g., tanks, armored cars, and aircraft". Note (below) the upper receiver, which appears to have been made from a blanked but not machined-out XM16E1 forging.

QAD (Ord) Pattern Room



INSTRUCTIONS

for the

INSTALLATION AND OPERATION

of the

COLT TWO - and THREE - SHOT
BURST CONTROL MODE

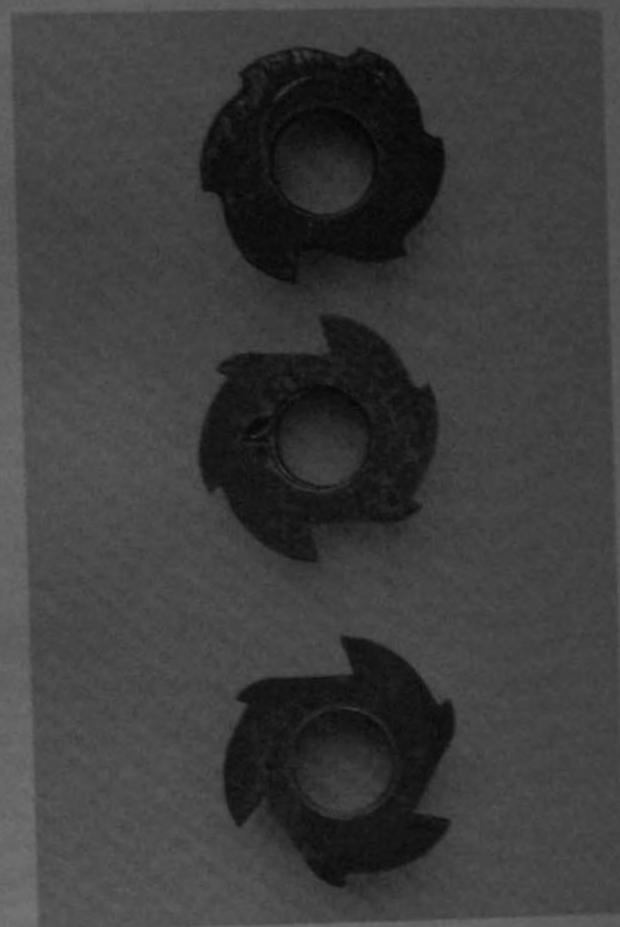
Parts contained in this modification kit
may be installed in

M16, XM16E1, Sub-Machine Gun
and Heavy Assault Rifle

MANUFACTURED BY

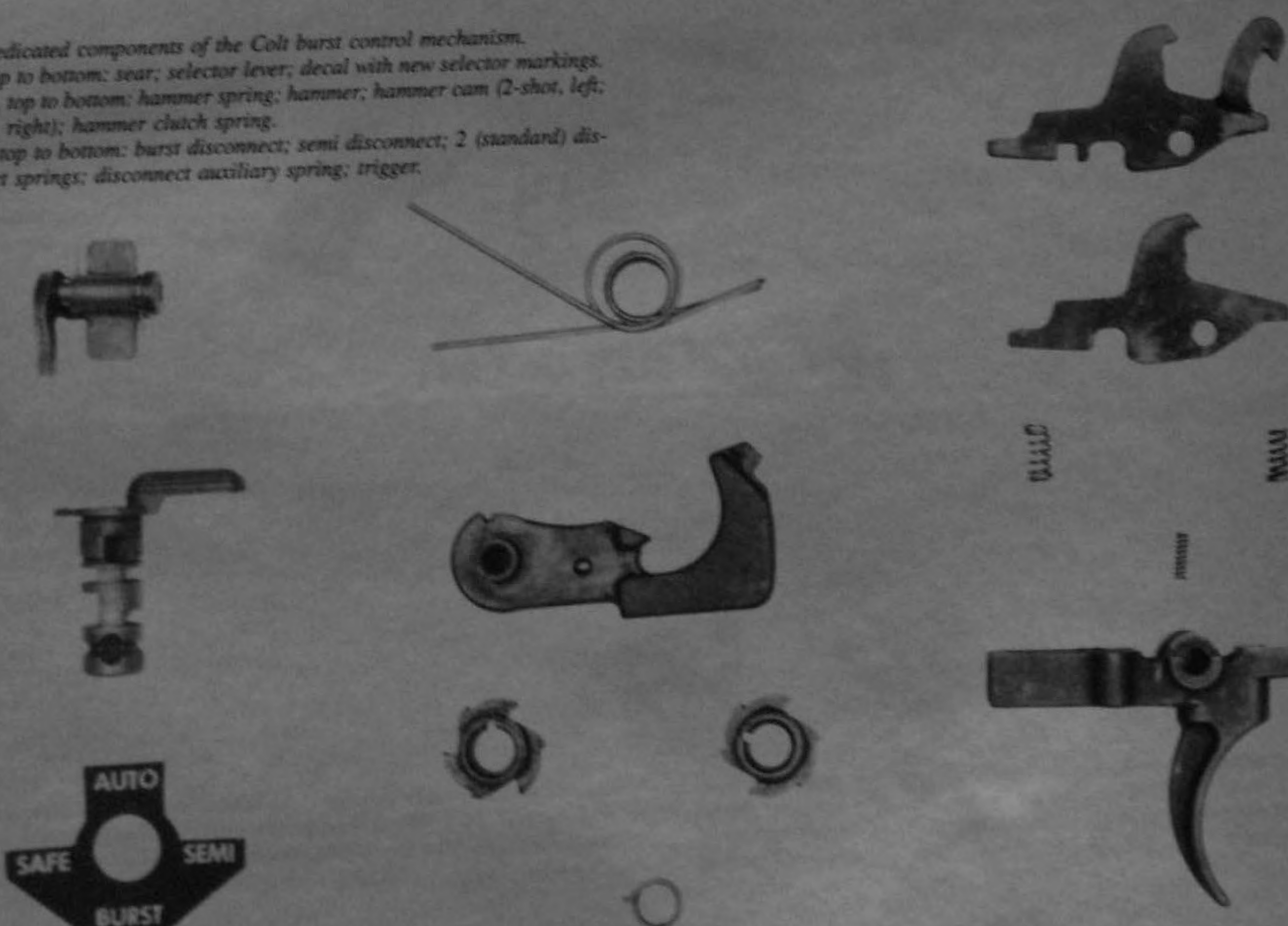
COLT FIREARMS DIVISION
COLT INDUSTRIES, INC.
HARTFORD, CONN.

169. Cover of Colt's instruction manual for its two- and three-shot burst devices, available on all models of the CAR-15 system.



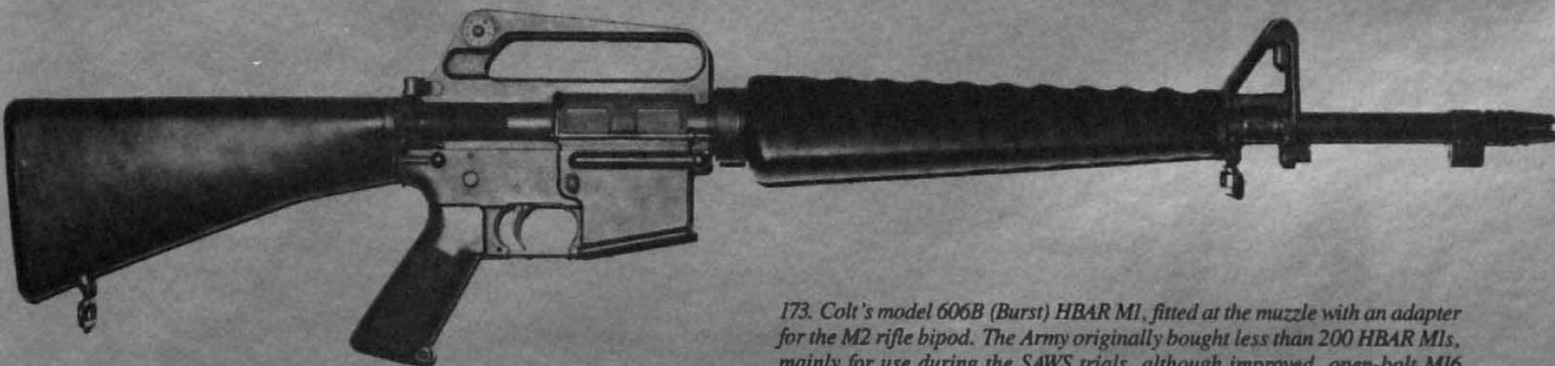
171. Closeup of three burst device hammer cams. From top: experimental "once-around" 6-shot; 3-shot; 2-shot. Bob Miller collection

170. Dedicated components of the Colt burst control mechanism.
Left, top to bottom: sear; selector lever; decal with new selector markings.
Center, top to bottom: hammer spring; hammer; hammer cam (2-shot, left; 3-shot, right); hammer clutch spring.
Right, top to bottom: burst disconnect; semi disconnect; 2 (standard) disconnect springs; disconnect auxiliary spring; trigger.



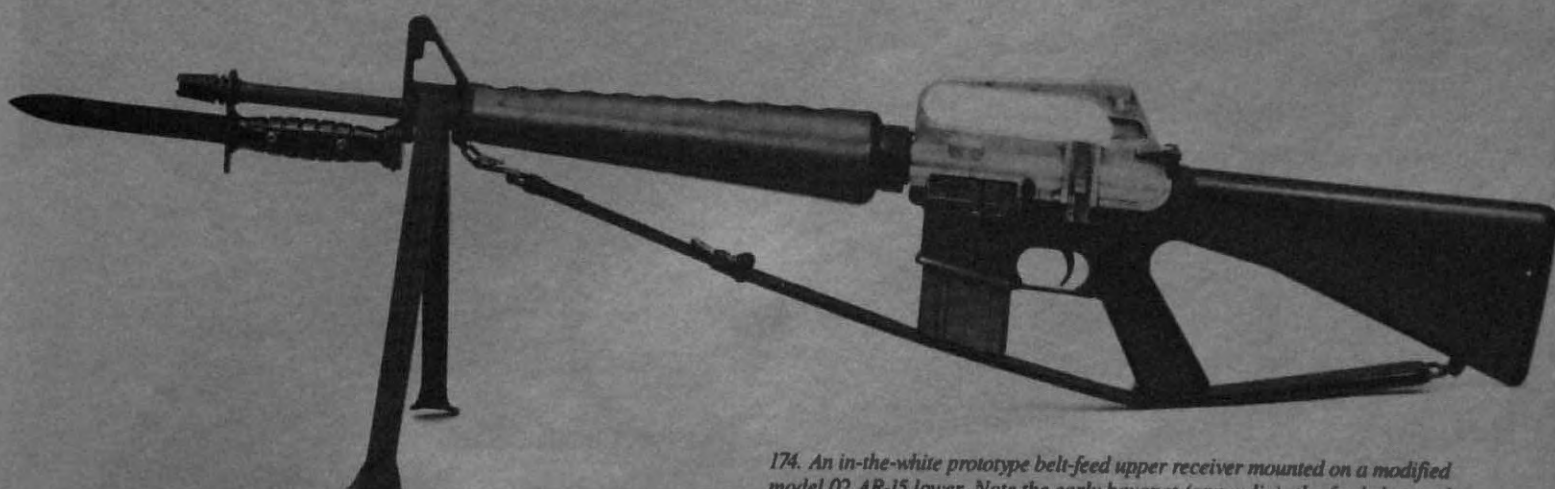
The CAR-15 Heavy Assault Rifle M1

172. The Colt CAR-15 HBAR "Heavy Assault Rifle M1". Weighing over a pound more than the 6.5-lb. M16/XM16E1, the M1 was variously fitted with a regular Colt "clothespin" bipod, a modified BAR bipod as shown here, or adapted for the M2 rifle bipod (fig. 173). This example, serial no. 039950, bears "AR-15 / Cal.223" export markings.



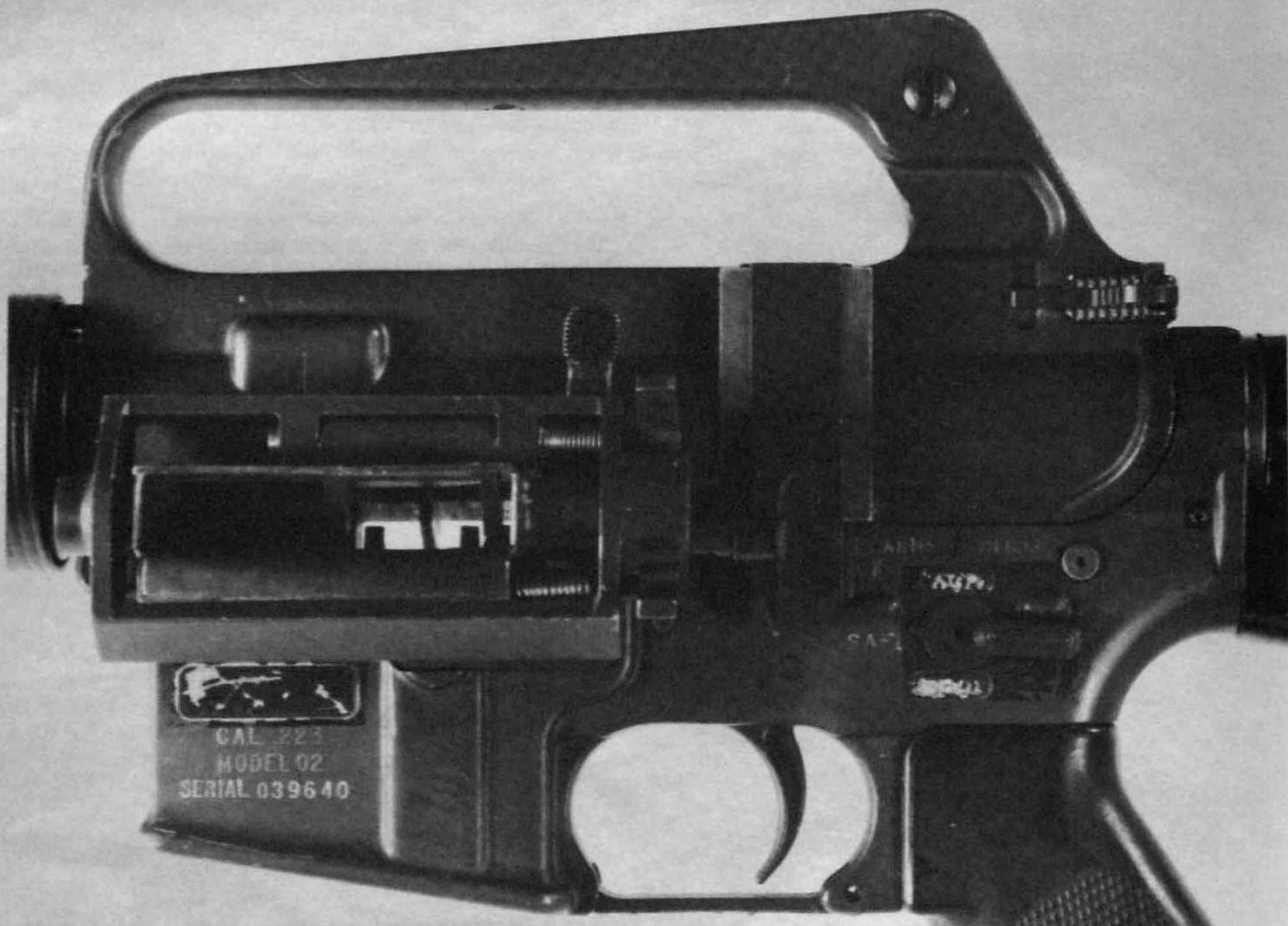
173. Colt's model 606B (Burst) HBAR M1, fitted at the muzzle with an adapter for the M2 rifle bipod. The Army originally bought less than 200 HBAR M1s, mainly for use during the SAWS trials, although improved, open-bolt M16 HBARs are alive and well today (chapter 23).
Rock Island Arsenal collection, photo by Richard S. Smith

The CAR-15 Heavy Assault Rifle M2 (Belt Fed)



174. An in-the-white prototype belt-feed upper receiver mounted on a modified model 02 AR-15 lower. Note the early bayonet (appendix), the feed slot, and the vertical actuator, which functions through a long cam slot in the modified bolt carrier (fig. 182, top).

175. Colt designer Rob Roy firing the original, regular-barreled belt-feed rifle shown in fig. 174. Note the three circled empties, and the links of the disintegrating belt exiting through the link ejection port.

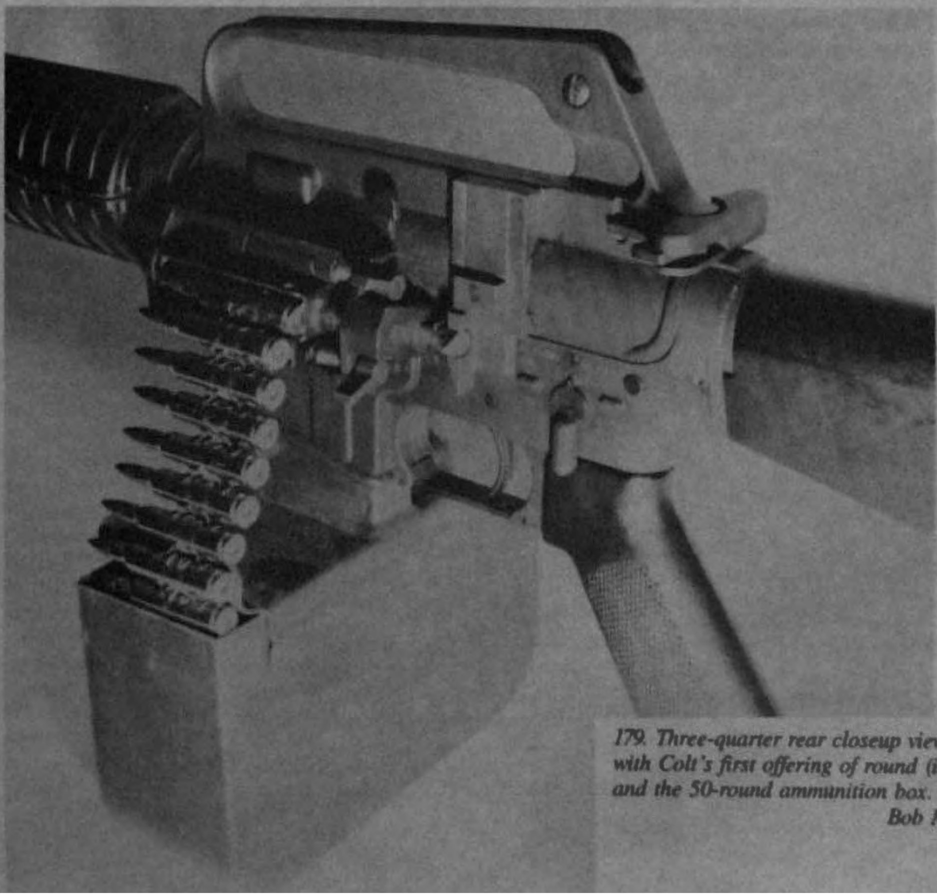


176. Receiver closeup of a modified Colt model 02 rifle adapted to belt feed. Note the link guide (vertical projection) in the link ejection port, visible through the feed opening, and the added 2 SHOT burst capability.

Photo credit: Eric Long, Smithsonian Institution

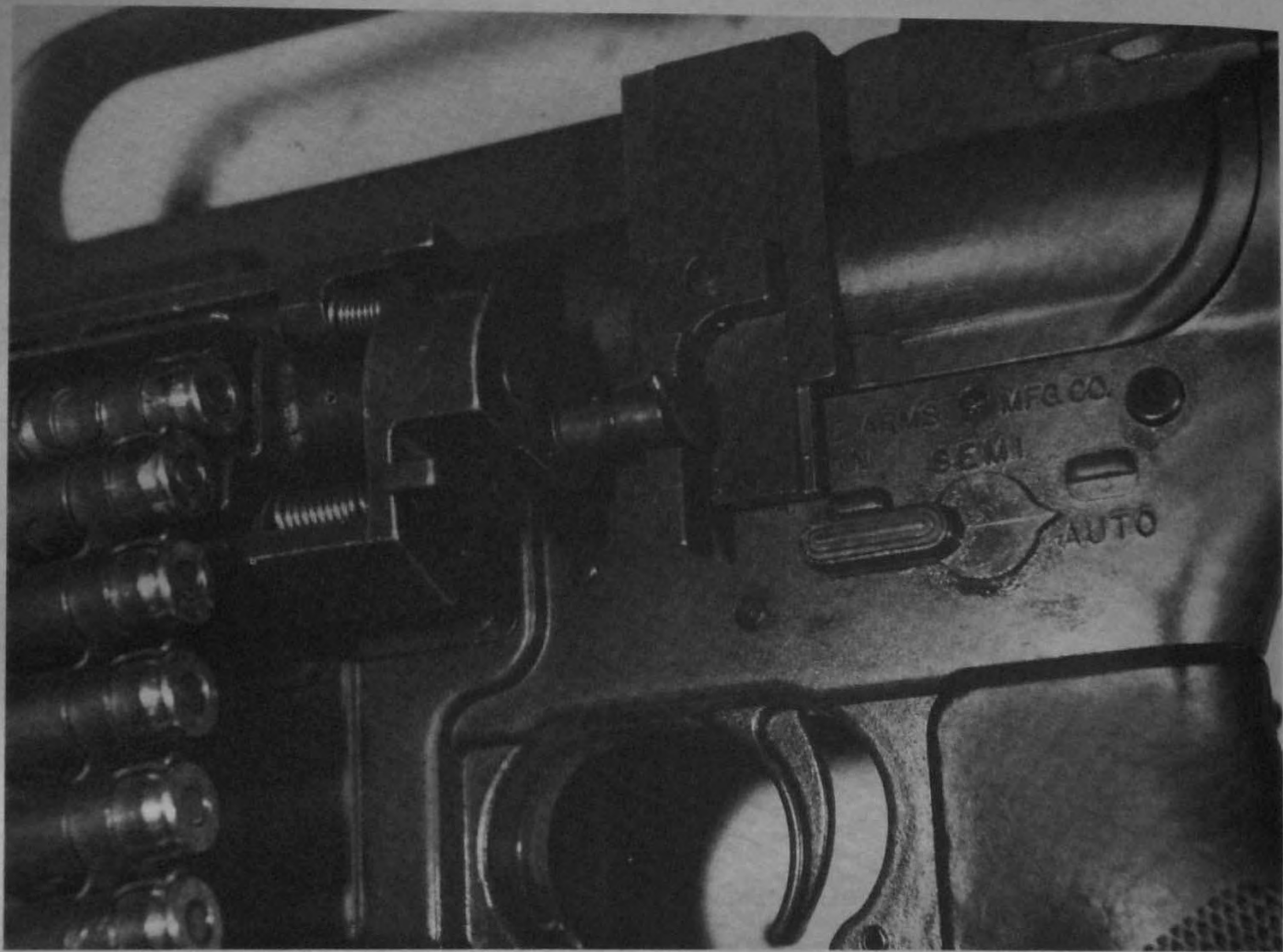
177. Colt belt-feed M2 HBAR, left side view with smaller (50-round) ammunition box.

178. Right side view of Colt's "CAR-15 Heavy Assault Rifle M2", officially listed as weighing 8.3 lbs. (without bipod or 120-round ammunition box, shown here). Note the "link chute", which channeled the spent links into a compartment in the right-hand side of the ammunition box. The Project Manager noted that a belt feed AR-15 was sent to Springfield Armory on November 10, 1964, to be evaluated as helicopter door armament. Less than 20 were ever made.



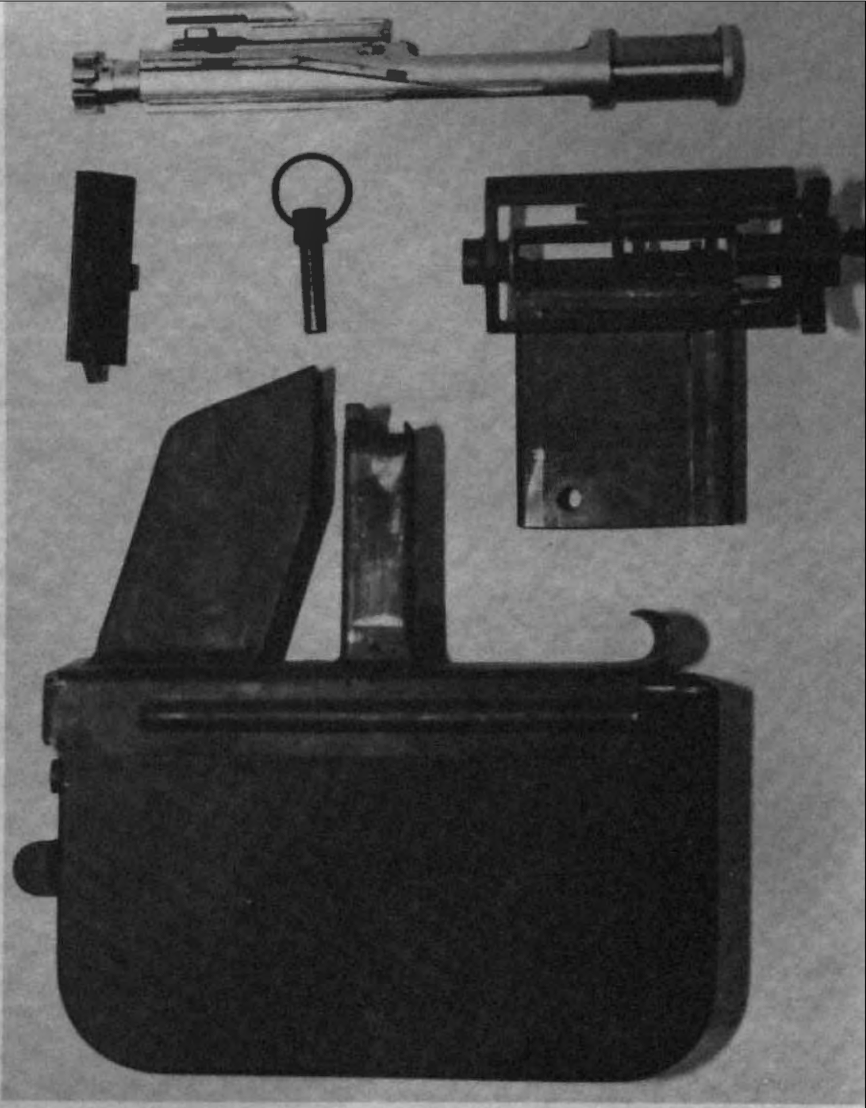
179. Three-quarter rear closeup view of another belt-feed HBAR M2, fitted with Colt's first offering of round (interchangeable) handguards (fig. 207) and the 50-round ammunition box.

Bob Miller collection, photo by Roy Arnold



180. Further receiver closeup of fig. 179. Note the rounded slot cut in the center portion of each Colt link, designed to mate with the link guide (fig. 176) and keep the links from twisting and jamming the action.

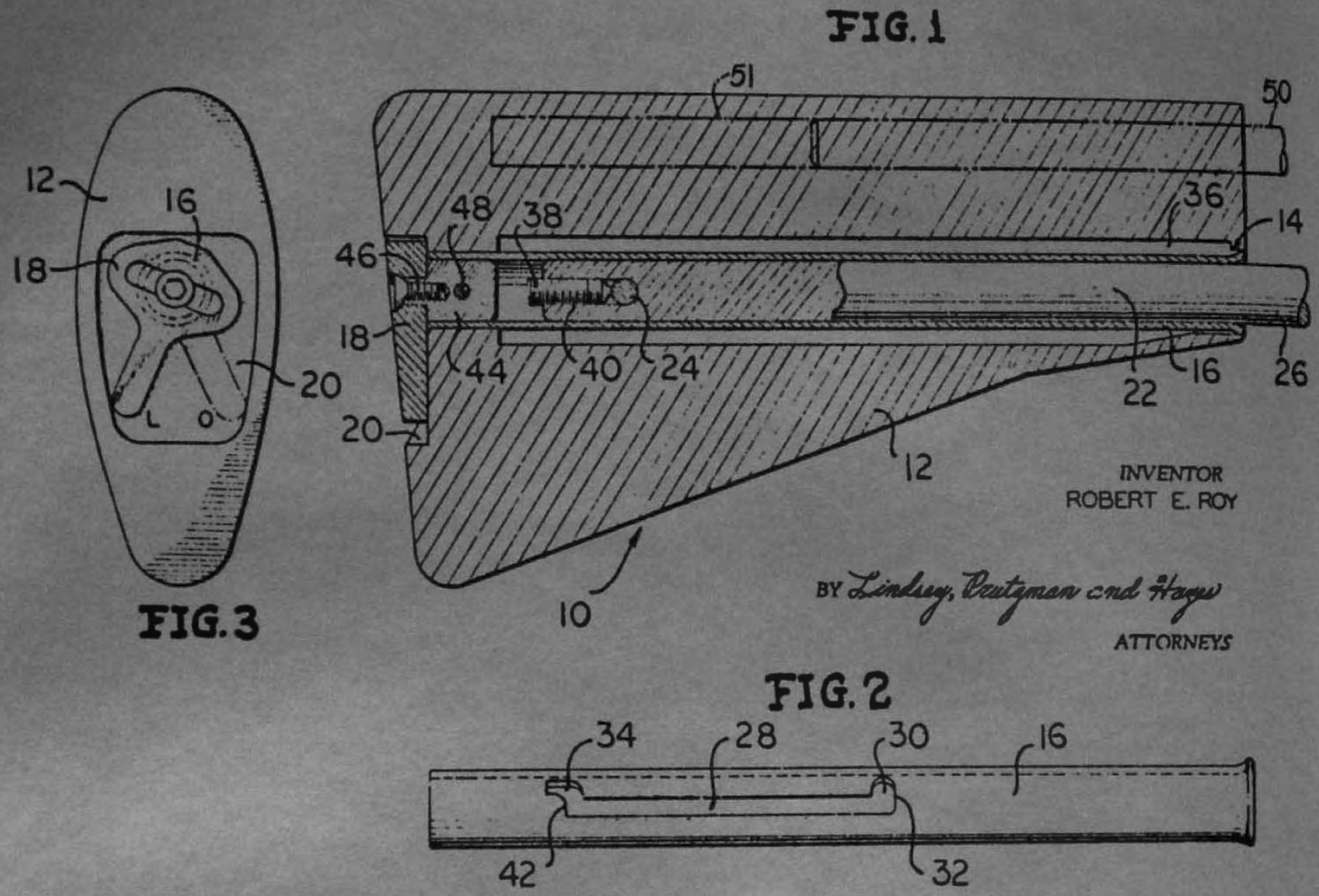
181. Closeup of an experimental, "handleless" upper receiver designed for belt feed. Note the vertical slot and guideway (right) through which the sliding feed actuator is cammed up and down by the long slot in the bolt carrier (fig. 182). Bob Miller collection, photo by Roy Arnold



182. *Components of the Colt belt-feed system used in the M2 HBAR.*
Above: bolt assembly (note the longitudinal belt feed actuating cam slot and lightened rear diameter of carrier).
Center, from left: belt feed actuator; magazine box demounting pin (secures center "dummy magazine" mounting projection of magazine box, below, to belt feed mechanism); belt feed mechanism, installed down *through magazine well of specially modified upper (fig. 181) and lower (fig. 176) receivers. Protrudes below magazine well to accept magazine box and (note hole) demounting pin.*

The CAR-15 Submachine Gun

183. *Two one-off, prototype CAR-15 submachine guns from the Colt model shop, both with 10" barrels and "bobbed" bayonet lugs and pistol grips.*
Above: early Colt (model 01) AR-15 featuring (from front) early standard flash suppressor; handmade front handguard retainer holding standard handguard shortened from front; *early charging handle; handmade prototype extendable buttstock (fig. 184).*
Below: later M16 with handmade rear handguard retainer and handguard shortened from rear. *Note "production" model of extendable buttstock.*
Bob Miller collection, photo by Roy Arnold



184. Figs. 1, 2 and 3 from US Patent no. 3,267,601, granted to Robert E. Roy and assigned to Colt's, entitled "Adjustable Length Buttstock". Not completely satisfactory, as it required the addition of a guide rod (22) and in any case the stock, operated by the lever (18), only changed the rifle's length by 2.7". Further development of the CAR-15 SMG is discussed in chapter 15.

185. Another one-off, toolroom model of the CAR-15 submachine gun, made from AR-15 serial no. 014864, featuring the plain (model 02) flash suppressor on a 10" barrel. No bayonet lug; export markings; early steel "waffle" magazine; standard pistol grip and extendable buttstock.
Bob Miller collection, photo by Ray Arnold

The CAR-15 Survival Rifle

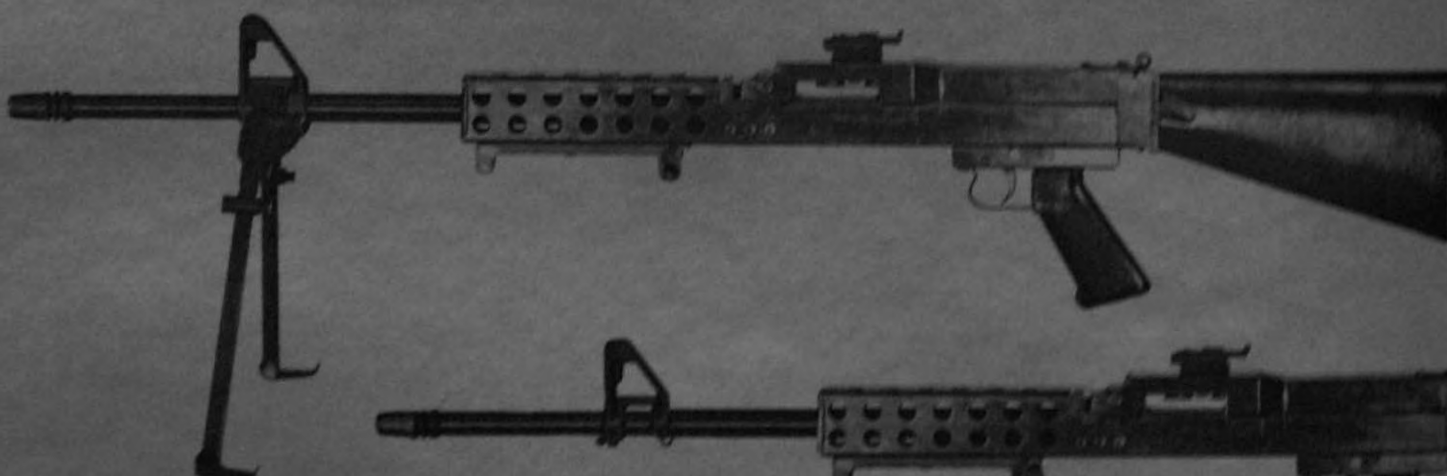
186. Right side view of two CAR-15 survival rifles (Colt model 608). Above: note the unique funnel-type flash hider and distinctive round handguard, the "bobbed" pistol grip and non-adjustable metal stock. Below: a later model featuring the first type of Colt's "noise and flash suppressor" (chapter 15), slightly longer pistol grip, and plastic-coated buttstock.
Bob Miller collection, photo by Roy Arnold

CAR-15 Survival Rifle (Disassembled for Stowage)

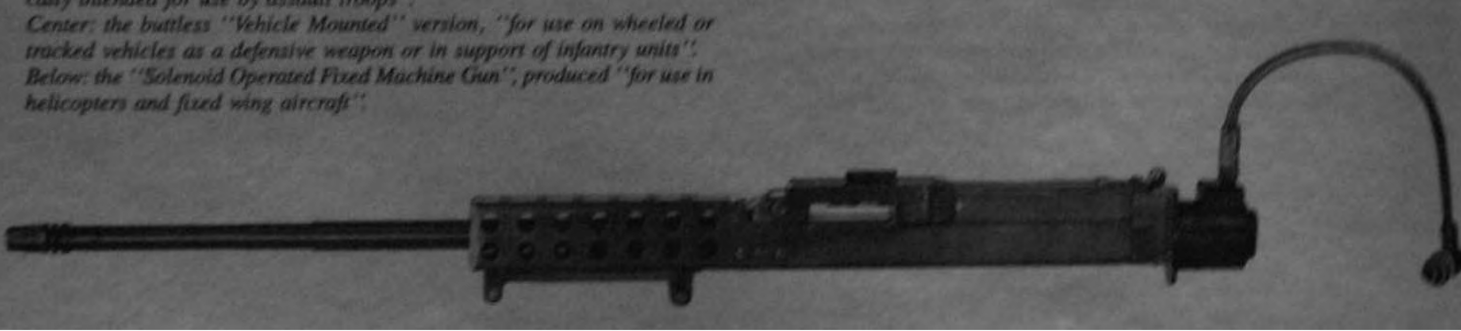
187. The Colt CAR-15 survival rifle as disassembled for stowage, along with 80 rounds of ammunition in 4 magazines, in the standard aviator's seat pack. 10" barrel, 29" overall length. Weight: 4.75 lbs. without magazine. Not adopted: estimates at Colt's are that less than 10 Survival Rifles were ever made.

The Colt CMG-1 Machine Gun

188. The short-lived Colt CMG-1, in the 12.5-lb./5.67 kg "Tripod Mounted Medium Machine Gun" version. Made extensively from sheet metal stampings, the CMG-1 was designed to feed belted 5.56mm ammunition from either side of the receiver, and fire from an open bolt. Rate of fire: 650 rpm. Only two or three CMG-1s were ever built. The first prototype featured an M16 bolt and gas tube, while the others were each built on different experimental gas (piston) systems.



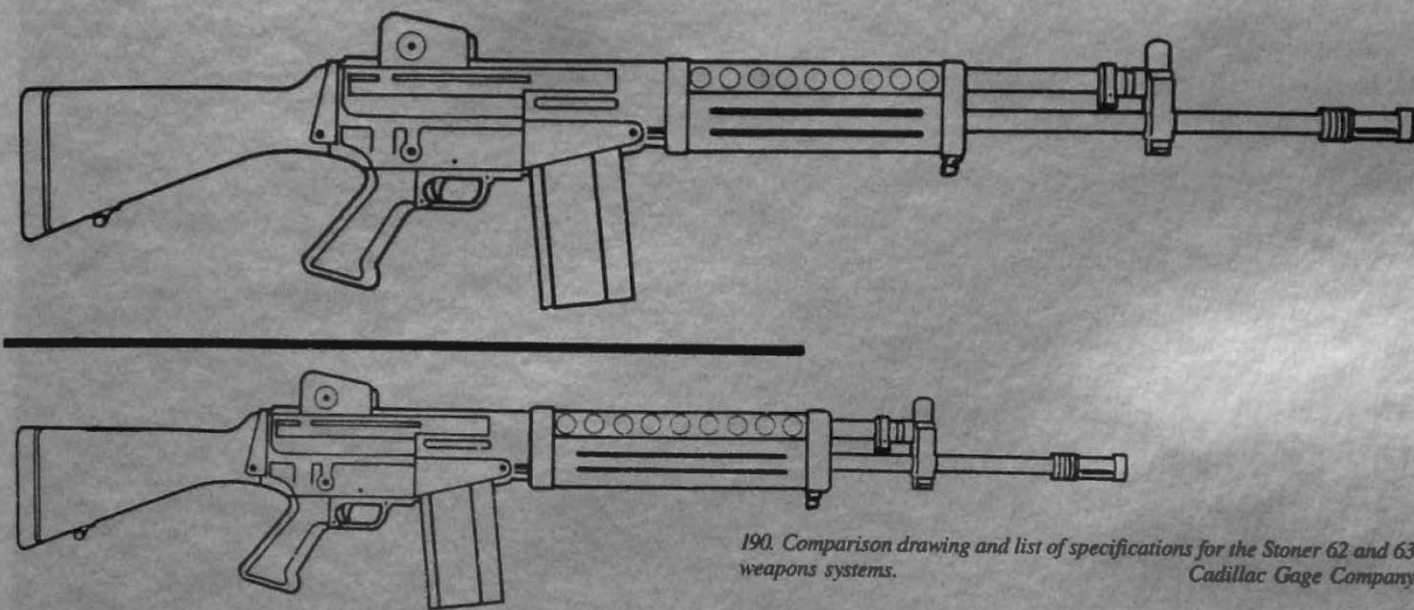
189. The other three proposed versions of the CMG-1 machine gun, as featured in the second edition of Colt's "CAR-15 and CMG-1" catalog (fig. 164). The designer noted that these seemingly ready-to-shoot CMG-1s "existed only in the minds of the advertisers".
Above: the 11.5-lb./5.22 kg "Bipod Mounted Light Machine Gun", "specifically intended for use by assault troops".
Center: the buttless "Vehicle Mounted" version, "for use on wheeled or tracked vehicles as a defensive weapon or in support of infantry units".
Below: the "Solenoid Operated Fixed Machine Gun", produced "for use in helicopters and fixed wing aircraft".



The 5.56mm Stoner 63: Strong Competition for Colt's CAR-15 Program

On the whole, M16s had so far done rather poorly in US Marine Corps testing. In fact, the issue of M16 rifles to USMC units was viewed within the Corps as undesirable, as there were no 5.56mm light machine guns or indeed any other support weapons officially available, and the net result would be to force yet another caliber into an already complex supply system.

Taking a leaf from Fairchild's book, the Cadillac Gage Company had in the early sixties made an attractive offer of employment to a Marine Colonel soon due for retirement, who during the latter part of his military career had convinced the Corps' Commandant, General Wallace Greene, of the advantages of a one-gun "family" for Marine use. Of course, Colt's had already presented their seven-version (six variations



190. Comparison drawing and list of specifications for the Stoner 62 and 63 weapons systems. *Cadillac Gage Company*

FEATURES:

* *Gas operated*
* *Rapid barrel change*
* *Selective fire (automatic and semi-automatic on the rifle version)*
* *Adjustable rear and front sights*
* *Winter trigger*
* *Instant field stripping and conversion without tools*
* *Grenade launching*
* *Accepts scope and infra-red sights*
* *Close bolt firing on riflle version*
* *Open bolt firing on belt-fed versions*

SPECIFICATIONS:		Stoner 62	Stoner 63
Caliber		*7.62 NATO*	*.223*
Length	*Rifle*	*42"*	*39"*
	LMG	*42"*	*39"*
	MMG	*32.25"*	*29.75"*
Weight	*Rifle W.O. Mag.*	*8.9 lbs.*	*6.5 lbs.*
	LMG with Bipod	*18 lbs.*	*10.5 lbs.*
	MMG W.O. Tripod	*16 lbs.*	*9.0 lbs.*
	Fixed MG	*16.50 lbs.*	*9.5 lbs.*
Length of Barrel		*20"*	*20"*
Magazine Capacity		*20 rds.*	*25 rds.*
Weight of Magazine—Steel		*.50 lbs.*	*.45 lbs.*
—Aluminum		*.25 lbs.*	*.25 lbs.*
Rate of Fire		*600*	*650*

191. Gene Stoner in late 1963, demonstrating the rifle version of an early wood-stocked prototype of the .223 caliber Stoner 63 at Camp Grayling, Michigan.
US Army Detroit Arsenal photo

192. Firing the wood-stocked Stoner 63 prototype in the medium machine gun version at Camp Grayling. Note the General's "expedient" earplugs.

plus the M16 rifle) CAR-15 series, but these were seen as "dedicated" individual configurations. The Marines apparently had in mind a more versatile system based on common, interchangeable sub-assemblies.

As for Cadillac Gage, it should come as no surprise that the scaled-down, 5.56mm version of Stoner's original 7.62 NATO model of 1962, called the Stoner 63, was an instant hit with General Greene and indeed fit the Marine specification perfectly.

Time Out For Some Stargazing

By November of 1964 the furor created by the Marine demand for the Stoner system, which the Army was doing its best to ignore on the grounds that modified M16s would be a preferable alternative, had caught Defense Secretary McNamara's ear, and reverberated back down to the Army Chief of Staff. At OSD level the pandemonium over the pros and cons of bolt assists, rifling twists and the ideosyncracies of various gunpowders was well remembered: certainly now that the M16 was adopted and in production, no "alternate" weapon purchases were contemplated.

193. The complete 5.56mm Stoner 63 system, as favored for adoption by the US Marine Corps, and tested in the SAWS study. The Stoner system boasted over 80% parts commonality among all its versions.

On the other hand, the M16 rifles coming into the system were almost exclusively for the use of the Air Force and other special airmobile units. For the Army, the XM16E1 was by definition just a stopgap until the SPIW became ready for issue, an event that had already begun to recede into the ever-more-distant future. The basic weapons available for general issue to the Army and the Marine Corps still comprised the NATO-caliber M14 rifle and M60 machine gun. With some decision obviously necessary in the dispute between the Army and the Marines over the Stoner system, it seemed as good a time as any to examine future small arms options in general.

The SAWS Study

For General Harold K. Johnson, the Army's newly appointed Chief of Staff, it was time to "completely re-evaluate our small arms weapons program, starting with a review of doctrine.."

..I am hopeful that the Marine Corps will subscribe to this approach, will monitor the efforts as they habitually do, and will not attempt to precipitate an early decision which could prejudice the future combat effectiveness of both the Army and Marine Corps.

In response to ever-louder Marine allegations that the Army had "a closed mind" on the issue of the Stoner system, General Johnson opined:

General Greene has given me oral assurance that he does not intend to pursue a course of action that diverges from that of the Army at this point.

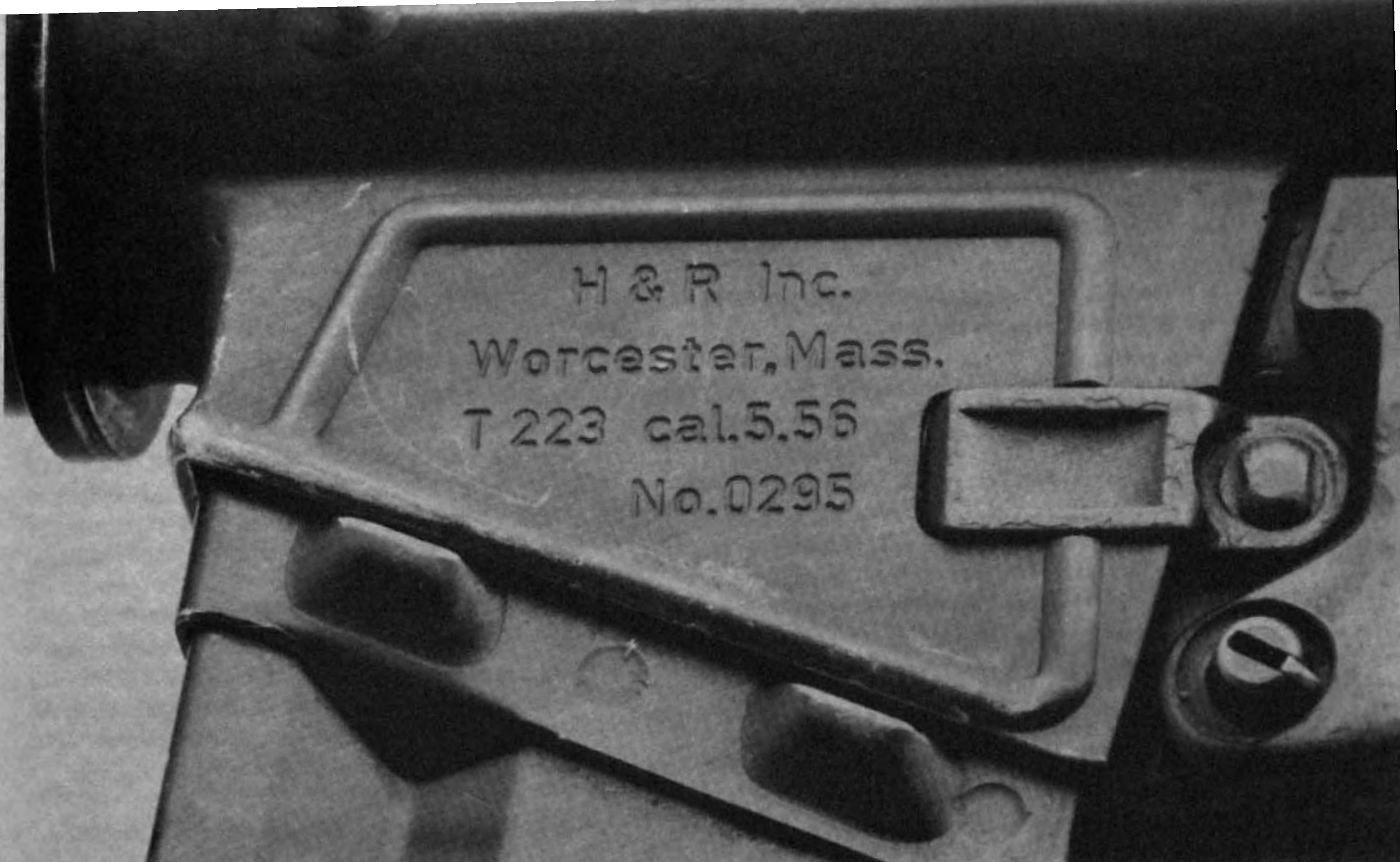
Thus began the elaborate "Small-Arms Weapons Systems" (SAWS) study, the implementation of which General Johnson entrusted to the Combat Developments Command (CDC). Over the next fifteen months, six major series of SAWS tests were performed in the US, the Arctic, Europe and the Caribbean on a number of weapons including the M14, light- and

194. The rifle version of the improved, 5.56mm Stoner 63A1 system. By 1970 the Stoner system as used in the SAW trials had been narrowed down to three improved versions: the XM22E1 Rifle (above); the XM23 Carbine; and the XM207 Belt Fed Machine Gun. A further improvement to this last, called the XM207E1, was adopted as limited standard by the US Navy SEALs as the "Machine Gun, MK23 MOD 0".

US Army Rock Island Arsenal photograph dated August 25, 1971

195. Circuitous Route Department: the Nederlandsche Wapen-en Munitiefabriek De Kruithoorn N.V. (NWM) of s'Hertogenbosh, Holland, a subsidiary of the German Mauser - IWK arms and munitions conglomerate, obtained in 1957 the world-wide rights to the Spanish CETME rifle, heir and embodiment of late-World-War-II German roller-lock technology. The rights to the CETME were sold to the West Germans in 1960, and the Heckler & Koch NATO-caliber G3 rifle was the result. With the burgeoning popularity of the .223 cartridge, it wasn't long before H&K introduced a 5.56mm version of its roller-locked "family", called the HK33.
Pictured above are left and right views of a "laundered" HK33 called the "T223", sponsored by Harrington & Richardson and entered in the SAWS trials.

196. Receiver closeup of the 5.56mm caliber HK33, disguised as the "H&R T223" for the SAWS trials. Note the selector markings: "Safe; S.A; F.A".



197. Closeup of receiver markings of the laundered "H&R T223".

heavy-barreled versions of the XM16E1, various developmental SPIW prototypes, the Stoner 63, the Soviet AK-47, a scaled-down 5.56mm version of the Heckler & Koch roller-locked G3 (the "T223", presented by H&R), and the Army's M60, M73 and M37 machine guns. As further discussed below and in *The SPIW*, the December 1966 final report of the SAWS study ran to over thirty volumes.

If nothing else, the SAWS exercises adroitly deferred any decision on the Stoner/M16 controversy for the following two years.

"Four Alternatives" for the Future - Reaffirming the SPIW

Also in November, AMC's Commanding General Frank Besson had queried the PMR as to a possible future termination date for the recently expanded yet essentially temporary "Project Management Office for Rifles". In his reply, classified "Secret" as were most communications dealing with the SPIW, Lt. Col. Yount presented four possible scenarios based on what the SAWS study might ultimately recommend. Significantly, the Army's current .30 caliber inventory formed the backbone of three of these, while all roads save the unlikely total regression "back to the .30 caliber" ultimately led to the SPIW:

Project Curtailment/Termination Study

3 December 1964

..Specific plans for Project Office termination have not been developed. A number of decisions must be made pertaining to the Army Rifle Program before definite plans.. could be prepared.

To develop specific plans, the Army Rifle Program should be considered from four alternatives.

Alternative 1 - *The Army is currently undertaking [the SAWS] study to determine the direction the Army will follow to select the ultimate..rifle...It is anticipated this rifle study will be complete and decisions made for paths to follow by 1 July 1966. Assuming the decision is made..to select the M14 as the best obtainable rifle, production could possibly be initiated in six (6) months. After approximately eighteen*

(18) months' production..the..Program..would lend itself to turning the item back to commodity management and deprojectizing the Project Management Office for Rifles [PMO]. This..is based on the assumption the Army would utilize current rifle assets, including XM16E1, M14, M1, and BAR to arrive at the total required Army rifle asset strength.

Alternative 2 - *Assuming the decision is made..to select the XM16E1 rifle as the interim rifle system prior to production of the SPIW as the ultimate rifle system. Production of the XM16E1 could be initiated shortly after the decision is reached, and the required Army rifle asset strength could be reached by February 1967 utilizing current rifle assets. Since the XM16E1 is currently in production, this portion of the Rifle PMO..could be dropped..however, the PMO would continue..to monitor development and production of the SPIW.*

Alternative 3 - *Assuming the decision is made..to select the Stoner or some other weapon as the interim rifle system prior to SPIW production...Again utilizing current rifle assets, the required Army rifle asset strength could be reached by late 1967 and this phase..could be..picked up by Commodity Management in early 1968. Here again, the PMO would continue..to manage the SPIW program.*

Alternative 4 - *Assuming the decision is reached..to select the SPIW as the ultimate rifle system. A thirty-five (35) month [SPIW] research and development program is currently being staffed by the Department of the Army...This phase is scheduled for completion in November 1967 and will be followed by a facility tooling period of one year; thereafter will follow a twenty-four (24) month pilot line production of 11,000 weapons. The initial production for troop use will begin in December 1970 and 195,000 weapons should be delivered in the first twelve (12) months' commercial production run. Replacing all current rifles with the SPIW would entail nearly seven years additional production...Under this alternative it would appear advisable to retain the SPIW under Project Managership until FY1973..*

The significant choice of words ("will" or "would" when describing the SPIW timetable, instead of "could") also reflect the Army's foregone conclusion to proceed with the SPIW.

Meanwhile, as noted in Col. Yount's 4th Alternative, the PMO was trying manfully to get the SPIW program back on track with a 35-month, "second generation" plan. Following an early "second generation" SPIW briefing at Fort Benning, the Commandant of the Army Infantry School described the crucial role which the Project Manager Rifles played for the Infantry, at the same time taking a few swipes at some of the SPIW's more glaring problem areas:

Headquarters United States Army Infantry School

Fort Benning, Georgia

10 February 1965

Dear General Besson:

As part of our continuing program to keep abreast of critical weapon developments, I was most pleased to have Lieutenant Colonel Harold W. Yount, your Project Manager for Rifles, and several of his technical advisors visit Fort Benning last week and bring us up-to-date on the status and progress of the Special Purpose Individual Weapon (SPIW).

This get-together..was successful beyond our own expectations. It clarified the problems which must be overcome and gave us an appreciation of the types of trade-offs that may have to be considered. Our "experts", on the other hand, had the opportunity to express and explain our strong feelings concerning the development of the combination, flechette point fire and multi-shot area fire, weapon.

Our meeting served to underscore the tremendous importance which we attach to this particular Project Manager...Of all the Army's project managers, he is the most important to the Infantry. All the resources at Fort Benning are available to insure his successful development of the SPIW..

The Decision to Close Springfield Armory

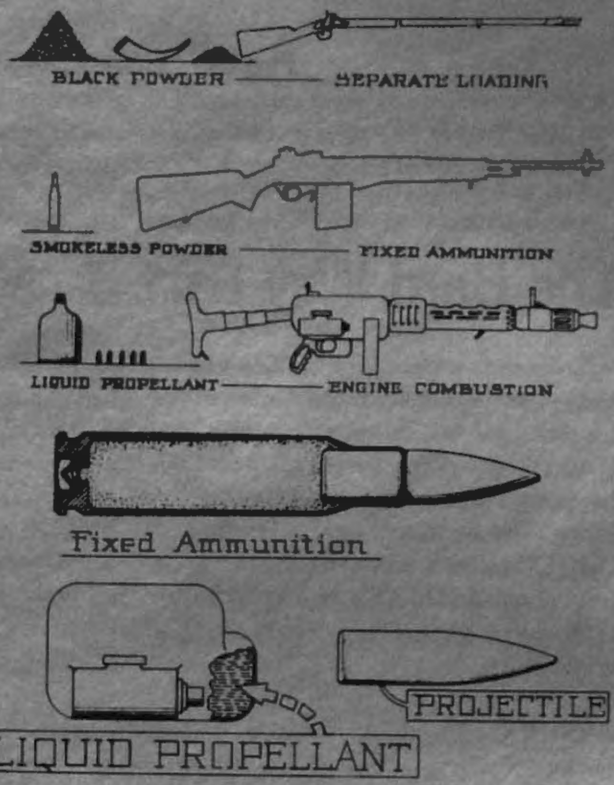
In presenting the fruits of a twenty-month, high-level study of the US Army Arsenal system at a November 1964 press conference, Defense Secretary McNamara announced "95 actions to consolidate, reduce or discontinue Defense Department activities in the United States and overseas". One of the actions thus announced was the decision to close Springfield Armory: in the name of "cost-effectiveness" the Defense Department had "examined its Arsenal System and identified additional excess capacity that is no longer needed".

The 174-year-old "National Armory at Springfield, Massachusetts" was the very hub of the country's military small arms

engineering development system. Inasmuch as power corrupts, it was a measure of Springfield's importance that over the years it had become a bastion of hidebound bureaucracy and blinkered traditionalism. As such, it stood aloof and in rankling opposition to Secretary McNamara's oft-professed credo to "use deliberate analysis to force alternative programs to the surface, and then to make explicit choices among them".

With the M16/XM16E1 and the recently re-directed SPIW programs standing as successful examples of his "better mousetrap", Secretary McNamara resolutely capped a full year of vociferous opposition from Springfield's many boosters on November 16, 1965, with the statement that "The long-term retention of the Springfield Armory for the acquisition of small arms weapons and weapons systems is neither necessary nor desirable." This was in the face of the fact that, in addition to its various engineering test programs in support of the M16/XM16E1 and the recently-ordered "second generation" Armory SPIW, Springfield was deeply involved in supporting specialized airmobile warfare in Vietnam. Almost all of the early helicopter armament systems were developed at the Armory.

Nevertheless, by order of the Secretary of Defense the Armory was wound down to a final termination date of April, 1968, whereupon the Armory's small arms R&D facility was to be transferred to Rock Island Arsenal in Illinois.



198. A somewhat epigrammatic Springfield Armory retrospective entitled "Evolution of Rifle and Ammunition Development". Intended as a graphic "statement of worth", but ignored by Secretary McNamara in his November 1964 Armory termination announcement.

Escalation in Vietnam

In March of 1965, exactly a year after Colt's had begun initial deliveries, XM16E1 rifles were deployed with the 173rd Airborne Division, officially the first US combat troops deployed in Vietnam.

Project:
Rifles [week of] 14-18 December 1964

Two priority overseas requirements were received this week: 315 rifles for Air Force, and 3,146 XM16E1 rifles for Army..

Project:
Rifles [week of] 28-31 December 1964

Navy has notified the Project Manager, informally, of a priority requirement for 500 of either M16 or XM16E1 rifles..

Project:
Rifles [week of] 18-22 January 1965

A priority 04 MIPR was received from Navy for 50 additional M16 rifles..

Emergency orders for small quantities of rifles had meanwhile been keeping Lt. Col. Yount busy juggling his monthly delivery schedules. A sampling from the PMR's weekly significant action reports for the period leading up to the first "official" deployment reads as follows:

Project:
Rifles [week of] 22-26 February 1965

By telephone, 23 February, USAF transmitted an urgent requirement (priority 02) for 3,022 M16 rifles for shipment overseas..

Project: Rifles [week of] 1-5 March 1965

..An additional [Air Force] priority requirement for shipment of 6,463 M16 rifles has been received...Whereas Army production could defer to the Air Force higher priority requirement, receivers for the Army rifles are different, and the availability of receivers for Air Force rifles is the limiting factor on production.

Project: Rifles [week of] 29 March - 2 April 1965

..The Project Manager..is awaiting response from the Navy to his offer to substitute M16 or XM16E1 rifles for the 1,000 caliber .30, M2 Carbines which cannot be made available to fill the Navy's requisition..

The Hard Way Part 5 - More Alternate Propellant Trials

By the early summer of 1965, Colt's had run out of CR8136-loaded test cartridges and had been shipped a fresh supply, this time loaded with the only powder available, WC846. In May and June they reported new problems in staying within the Army's upper cyclic rate limit of 850 rpm on acceptance testing, and again requested a standing waiver to 900 rpm. The TCC refused, and a standoff occurred: Colt's suspended production of XM16E1s and henceforth would make only M16s, which the Air Force would accept with cyclic rates up to 900 rpm.

The TCC contacted the nation's powdermakers and requested test lots of new powders, with a view to further acceptance trials at Frankford. DuPont, having withdrawn its first two offerings, submitted yet another IMR type, and Hercules had improved its HPC-10. Significantly, Olin declined to enter any new propellant, stating that WC846 ball powder was as good as they could make it without a protracted and very expensive enhancement program. Since most of the ammunition loaded after the beginning of 1965 contained WC846, it was included in the Frankford study as the "control".

Excerpts from the report of the new trials, issued over the signature of C. E. Schindler, Chief of the Propellants and Pyrotechnics Branch of Frankford Arsenal, are as follows:

Fifteenth Memo Report on XM16E1 (or AR-15) Rifle/Ammunition System

Investigation of Alternate Propellants For Use in 5.56mm Ball and Tracer Ammunition

September 1965

Introduction

In April 1964, a similar program..resulted in recommending for approval propellant types DuPont CR8136 and Olin WC846. Production experience..later indicated the need for evaluating new propellants which might offer a more favorable pressure-velocity relationship..

In February 1965, DuPont and Hercules were contacted.. regarding a proposed test program..[and] both concurred... In June of 1965, Olin formally declined participation by concluding that significant improvements in the performance of their WC846 propellant could not be accomplished without a major effort..

Test Material

The test material consisted of three samples of approximately 20,000 cartridges each containing respectively DuPont EX8028, Hercules HPC-11 and Olin WC846..

DuPont EX8208-4

EX8208..has a normal IMR-base grain composition (single base, tubular, extruded) and is coated with a polymer type deterrent (ethylene dimethacrylate). Chemically this propellant corresponds to IMR8138-M, which is approved for 7.62mm Ball, M80, ammunition. The grain size, however, corresponds to CR8136, a single-base propellant currently approved for..M193 ammunition...The sample lot..was assembled by the Remington Arms Co.

Hercules HPC-11

HPC-11..has a double base grain composition (tubular-extruded) and uses ethyl centralite as the deterrent coating ...The sample lot..was assembled by the Federal Cartridge Corporation.

Olin WC846

WC846..has a double-base grain composition having a spherical appearance (ball) and uses dibutylphthalete as the deterrent coating. The preponderance of 5.56mm Ball M193 ammunition has been loaded with WC846 propellant in the last two years. For this reason, WC846 was selected as the control..The sample..was assembled by the Remington Arms Co.

Reference Ammunition

..As there is no government-loaded reference ammunition of this caliber to be used as a ballistic standard..commercial reference ammunition was employed for that purpose. The lot used was RA 55-5-R containing WC846 propellant.

Velocity and Pressure Tests

Normal Ambient (+70°F):

	EX8208	HPC-11	WC846
Velocity, fps at 15 feet Average (corrected)	3,235	3,227	3,230
Chamber Pressure, psi Average (corrected)	44,000	47,200	43,300
Port Pressure, psi Average (corrected)	15,700	14,300	15,500

Fouling

EX8208: No stoppages attributable to visible fouling... Only a moderate amount of fouling appeared on the bolt assembly area after the initial 1,500-round firing and after each subsequent 1,000-round cycle during the 6,000 round erosion test.

HPC-11: ..without any stoppages attributable to visible fouling...HPC-11 caused the least amount of fouling..of the three propellants tested.

WC846: ..failures to eject occurred repeatedly after 1,100 rounds in one weapon. These stoppages were attributable to excessive fouling in the bolt mechanism...it was obvious that WC846 caused considerably more fouling..in the bolt assembly area than did either of the other test propellants.

Gas Tube Fouling

Examination of the weapons used during the Erosion test indicated that though HPC-11 gave the least amount of visible fouling in the bolt assembly area, the gas tube was becoming increasingly constricted. This constriction appeared to correspond to large numbers of gun stoppages occurring, of the type normally associated with short-recoil and low operating energy in general. A comparison of the changes in the gas tubes inside diameters is tabulated below:

Propellant	*EX8208*		*HPC-II*		*WC846*	
Rifle No.	*141102*	*141161*	*141320*	*142265*	*142396*	*142926*
Internal dia., inches						
New Rifles	*0.116*	*0.116*	*0.116*	*0.116*	*0.116*	*0.116*
at 1,500 rounds	*0.116*	*0.113*	*0.093*	*0.078*	*0.116*	*0.113*
at 2,500 rounds	*0.116*	*0.113*	*0.093*	*0.078*	*0.116*	*0.113*
at 4,500 rounds	*0.116*	*0.116*	*0.081*	*0.063*	*0.113*	*0.113*
at 5,500 rounds	*0.116*	*0.113*	*0.078*	*0.073*	*0.113*	*0.113*
at 6,000 rounds	*0.110*	*0.104*	*0.099*	*0.099*	*0.099*	*0.106*

Propellant Alternation

To determine if there was any significant effect on weapon function...three 700-round cycles were fired. For each cycle, the propellant was alternated every 100 rounds...The weapon was cleaned after each 700-round cycle. The tabulated results follow:

Rounds fired	*Propellant*	*Cyclic rate*
100	*HPC-II*	*742*
200	*EX8208*	*875*
300	*WC846*	*841*
400	*EX8208*	*890*
500	*HPC-II*	*765*
600	*WC846*	*905*
700	*HPC-II*	*758*
800	*EX8208*	*880*
900	*WC846*	*905*
1,000	*HPC-II*	*772*
1,100	*WC846*	*905*
1,200	*EX8208*	*833*
1,300	*HPC-II*	*754*
1,400	*EX8208*	*818*
1,500	*WC846*	*875*
1,600	*HPC-II*	*734*
1,700	*EX8208*	*853*
1,800	*HPC-II*	*—*
1,900	*WC846*	*853*
2,000	*EX8208*	*821*
2,100	*WC846*	*773*

The average cyclic rate for each propellant is as follows:

EX8208 854
HPC-II 756
WC846 880

Only one malfunction occurred during this test. This was a "failure to fire" with HPC-II during the [third cycle, above].

Observations

Engineering tests designed to evaluate commercial product types, such as this..program, can evaluate such types only to the degree that the..samples used actually represented the respective types...It is essential that propellant producers control the raw materials and processes..so that subsequent lots are not significantly degraded from the sample found satisfactory..

The control propellant (WC846) gave the greatest amount of visible accumulation of residue in the bolt assembly area...Though WC846 meets current acceptance criteria for fouling, it appears to be marginal in this regard after between 1,000 and 1,500 rounds without cleaning; WC846 loaded cartridges will cause stoppages attributable to excessive fouling in the bolt mechanism..

None of the [acceptable] test propellants appears capable of consistently meeting the current XM16E1 rifle cyclic rate requirement of 750+/-100 [rpm]..

Conclusions

..EX8208 propellant..is suitable for use in 5.56mm Ball M193 and Tracer M196 ammunition and affords a substantial advantage over the currently approved CR8136..

HPC-11..cannot be considered suitable for use at this time.

The control propellant, WC846 though otherwise satisfactory, does produce quantities of fouling..sufficient to affect weapon function if the weapon is not cleaned after firing a maximum of 1,000 cartridges.

Recommendations

That..EX8208 be approved for use in..Ball M193 and Tracer M196 ammunition.

That current approval for use of CR8136 in the same type ammunition be withdrawn.

That current approval of IMR4475 propellant for use in the 5.56mm Tracer M196 cartridge be withdrawn.

That Hercules Powder Company be encouraged to expedite their efforts to overcome the "low operating energy" problem of HPC-11 and thus permit future approval..

That..Olin..be encouraged to modify their WC846 propellant so as to reduce the quantity of fouling deposits normally produced in the XM16E1 rifle..

The TCC was thus forced to authorize yet another marginally acceptable propellant in order to break the "M16s-only" stalemate at Colt's, and to silence the critics of their previous "sole source" position with regard to Olin's WC846. The ball powder in the preponderance of the ammunition destined for Vietnam was again found to produce fouling. This time the warning was even clearer: WC846 could stop a brand-new XM16E1 cold, anytime after 1,000 rounds had been fired without proper cleaning.

Ammunition loaded with DuPont's third propellant type, EX8208, did not start to come into the system until June of 1966. Until that time, WC846 was the only qualified propellant for loading 5.56mm cartridges.

The stage was set for the massive US military buildup in Vietnam, which was soon to begin.

Chapter Twelve

A TIGER BY THE TAIL

Reaction from troops in training, while important, was obviously not the same thing as how the M16/XM16E1s were faring in actual combat. General Besson was intensely interested in initial reactions from the 101st and 82nd Airborne Divisions and the Special Forces for more than just reasons of good management: the Vice Chief of Staff himself had "lit a fire" under General Besson for the same information. It was with great relief, therefore, that in April 1965 AMC could in all good conscience pass on word of the first month's "almost unanimously favorable" combat reports from these special units.

The relief was short-lived, however. For one thing, as the Project Manager reported, the TCC's M16 Introductory plan was soon going slightly awry:

Project: Rifles [week of] 24-28 May 1965

Teletype messages from both USARPAC and USARSO denied theater clearance for visit of the XM16E1 Rifle Technical Assistance Team. USARO stated that there were no supply or maintenance problems with this weapon. USARPAC stated that in view of the Field Commanders' Report being submitted quarterly, a visit of the team was considered unnecessary. However, none of these quarterly reports have been received to date from Vietnam..

As far as American fighting experience went, the terrain and climate of South Vietnam resembled nothing so much as the Pacific islands and jungles of World War II. As discussed in *US Rifle M14*, the initial and powerful "groundswell" behind the idea of a general-issue *selective fire* rifle had originated in the sudden, sharp actions of the Pacific campaign.

In Vietnam around the end of 1965, US forces first engaged disciplined, regular troops of the North Vietnamese Army in the bloody battles of Ia Drang. The enemy's "arm of choice" was the AK47. General Wheeler's "worldwide" trials had shown the AK to be "clearly inferior" to US weapons, and most US soldiers at that time had shown a preference for the M14 over the then-AR-15. But that was 1962 and peacetime, and this was 1965 and counting. America was at war in the jungle, again.

It is evident that General Besson truly believed the selective-fire M16 to be the best available US weapon for jungle and rice-paddy warfare, so much so that in his April report he warned the Vice Chief of Staff of what he saw as a "potential flare-up" from regular soldiers armed with semi-auto M14s who had a chance to become acquainted with the merits of the XM16E1.

However, as glimpsed above in the PMR's Four Alternatives, the Army had no intention of replacing its .30 caliber inventory at this time. The duration of the American presence in Vietnam was as yet uncertain, and moreover the SAWS trials were still running their course: until their conclusion, still over a year away, everyone had more or less agreed on maintaining the small-arms *status quo.*

As early as the first month of deployment, however, as was pointed out over the signature of the PMR's Washington-based Staff Officer (PMSO) Lt. Col. Robert C. Engle, there *were* some loose ends:

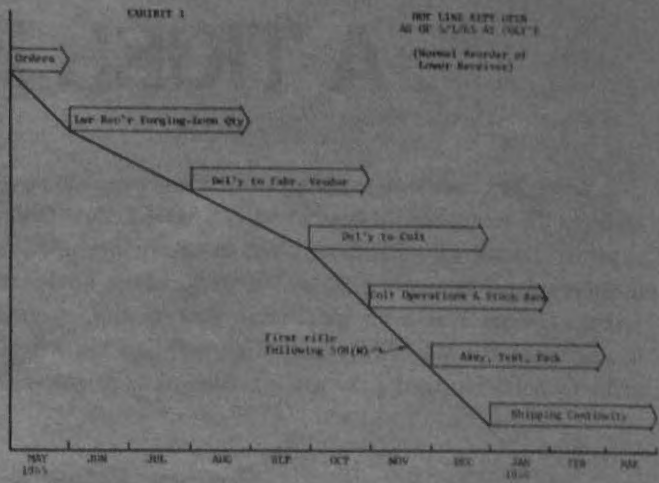
Project: Rifles [week of] 15-19 March 1965

Repair Parts for XM16E1 Rifles*: Since M16/XM16E1 rifle production by Colt's is scheduled to end in December 1965, the question of future repair parts support has arisen. Colt's has proprietary rights on manufacture of the rifle and components, and necessary repair parts will have to be procured from Colt's on a sole source basis...Regardless of the Army's decision concerning the disposition of the Army's XM16E1 rifle inventory, we are committed to support this weapon for the USAF on an indefinite basis..*

Colt's at the Point of No Return

Colt's had meanwhile been looking ahead to the day when the "one-time buy" contract would be completed. In February 1964, even before production began, Colt's had advised the PMR that May of 1965 would be "the point of no return", past which time no more orders *could* be accepted. Colt's would then have on hand just enough crucial "raw" materials, such as the aluminum forgings destined to become upper and lower receivers, to fill the rest of the existing contract. In the absence of new orders, the foundries which had been supplying the forgings to Colt's would then convert to other work. This would render any subsequent reorder plan time-consuming and expensive.

The ultimate effect of Colt's "squeeze play" went untested, however. As fate would have it, an eleventh-hour request for more M16s from the Air Force saved the day. In late May the PMR reported receipt of a letter from Wright-Patterson AFB announcing an FY66 procurement of 65,358 M16s, nearly double the number of rifles the Air Force had previously been thought to want, plus "continuing procurement of similar quantities each succeeding year through FY70." Curiously, upon inquiry, nobody could be found who would confirm these inflated requirements, and the USAF procurement slipped back to the original 36,682 M16s, still sufficient for the Project Manager to report that "This should extend Colt's production through April 1966."



199. Colt's graphic illustration of the lead time necessary to ensure an unbroken flow of XM16E1/M16 rifles after completion of contract "508". The "point of no return" for reordering is shown as May of 1965.

In the summer of 1965, small arms being issued to the ARVN (the US-trained-and-equipped Army of the Republic of South Vietnam) were still largely US weapons of World War II-through-Korea vintage: .30 M2 Carbines, .30M2 BARs, a variety of .30 caliber machine guns, and .45ACP submachine guns. The issue rifle for all regular US Army and Marine troops was the M14. The US was committed to maintain, and supply ammunition for, all of these weapons. In contrast, regulars of the NVA (North Vietnamese Army) were issued the selective-fire 7.62x39mm AK-47, which by this time was also beginning to supplant the hodge-podge of weapons previously used by the Viet Cong. The American weapons, although basically reliable and well-liked, were generally heavy in both weight and recoil, and thus at a serious disadvantage when compared to the enemy's AK-47 in the crucial parameter of *mean burst spread*.

Meanwhile, the special Assault, Airborne, Air Cavalry and Green Berets who had been issued with the selective-fire AR-15-cum-M16/XM16E1 were unanimous in their praise of "the Black Rifle", as the Viet Cong had first termed it. The Americans found the AR-15 ideal for both the small-statured ARVN troops and jungle fighting in general. In July, the Commander of US MACV (Military Assistance Command, Vietnam) General William Westmoreland, asked General Besson at AMC to look into the logistic considerations involved in a much-expanded issue of 5.56mm rifles for all the American troops in Vietnam.

A Field Commander's Call for Arms

As illustrated earlier in the "water-in-the-bore" episode, there are any number of ways to describe a situation, with emphasis (or the lack of it) here or there imparting a totally different meaning to the same "facts". General Westmoreland's celebrated call from the battlefields of Vietnam for 100,000 more XM16E1s is described in the following excerpt from a later (1975) background paper entitled *Acquisition of the M16 Rifle*, by James B. Hall, Colt's military sales manager:

..When I joined Colt in 1965, they were on the last of a contract with the Army for the XM16E1...This was the Army's position because Secretary of Defense McNamara and the Army's Chief of Staff, General Johnson..did not want to

spend more money for any new weapons but to use the current supply of M14s.

The M14 was a very inadequate weapon for use in jungle fighting since it was incapable of getting off a three-round burst without losing the last round...The AR-15 was a perfect application for this purpose and was recognized by Westmoreland and all his staff..

By refusing to allow Colt's to ship rifles anywhere throughout the world, although they had outstanding contracts with letters of credit..McNamara was able to tell the American public that every rifle coming off the Colt line was going to the soldiers in Vietnam. Colt at that time was working on a one-shift basis. It was an extremely political situation.

Members of the Congress became actively involved. The Army Staff was trying to get the 100,000 rifles that Westmoreland had requested in September..which General Besson.. supported but couldn't get approval from the Chief of Staff or the Secretary of Defense. After many discussions with Army personnel in Washington and with Congressional staffs, I wrote [in October 1965] to Brigadier General Jack Crowley, an old acquaintance, who was then the J-4 for General Westmoreland and advised him that effective the following January [Colt's] would stop producing rifles for the Army and he was fighting a war without any support...General Crowley..gave my letter to General Westmoreland..and [it] was the basis for..Westmoreland's discussion with a Senator from the Armed Services Committee who visited Vietnam in December...Westmoreland said there were a number of things he was unable to obtain and the Senator said he would see what he could do. [He] went out to the Air Force radio, bypassing Army command channels, called Senator Russell, the Chairman of the Senate Armed Services Committee and told him the story. Senator Russell in turn called Secretary McNamara and said "buy 100,000 rifles today, or I'm releasing the story to the press." That was December 7th. I received a call that date to be in Rock Island to sign a contract and if I didn't get there they would sign it without me. I didn't get there because of a snow storm in Chicago. They signed it and I signed it the next day.

Six months into the war the PMR reported "first news" of a phenomenon which had already been noted by Springfield Armory in its 1956 trial of the ArmaLite AR-10 (chapter 2):

Project: Rifles [week of] 2-6 August 1965

XM16E1 rifle: *Informal reports have been received that some problem may exist with "freezing" of the bolt and bolt carrier..under climatic conditions encountered in Vietnam...The result of freezing is that the bolt cannot be opened manually. Change 3 to the XM16E1 Technical Manual, published 1 May 1965, officially implemented improved cleaning procedures. However, to preclude the freezing problem...a technical investigation of the asserted problem was initiated ...Upon completion..corrective action will be taken..*

The Hard Way Part 6 - The Connection Is Confirmed

Meanwhile, as noted, DuPont's second IMR propellant offering had not lived up to expectations. Even though it was more uniform than the original IMR4475, DuPont could not guarantee that *every lot* of CR8136 would meet the tight average upper chamber pressure limit set by the Defense Department. Faced with the prospect of occasionally scrapping an entire lot of otherwise acceptable gunpowder, Remington had chosen to withdraw CR8136 in December of 1964. Remington had subsequently fulfilled its contractual commitments by loading with Olin's WC846 ball powder. This meant that all through the first eighteen months of the war in Vietnam, Olin's WC846 was the only qualified propellant for the M193 round.

In May of 1964 Bill Davis, the AR-15 Project Manager for ammunition at Frankford Arsenal, temporarily joined Colt's Firearms Division with the title of XM16E1 Engineering Project Manager. In this capacity he brought a wealth of invaluable experience to bear on Colt's share of the program's problems. In the process he irrefutably confirmed some obvious connections between ammunition type and rifle performance which the Project Manager's Office, intent on supplying rifles to the field, was still trying resolutely to ignore:

Colt Industries Inc

Colt's Firearms Division

Effect of Ammunition Variables on Acceptance Testing of XM16E1 Rifles

(First Partial Report)

November 8, 1965

Introduction

The prescribed cyclic rate of fire for the XM16E1 rifle is 650 to 850 rds/min, based on the average rate measured during a 20-round continuous burst. The parameters affecting rate of fire have been adjusted, in design of the rifle, so as to give a typical rate of 750 rds/min..

During testing of production rifles, a marked change in the cyclic rate was observed to correspond with a change from ammunition employing tubular-grain propellant to ammunition employing spherical grain (ball) propellant..

The purpose of this first report is to present..the results of a typical experiment..to ascertain the magnitude of the.. effect in a random sample of 52 production weapons.

Procedure

The 52 rifles were chosen at random from regular production. Two lots of M193 ball ammunition were used: Lot RA5060 containing [CR8136] propellant, and Lot RA5135 containing [WC846] ball propellant.

..Each rifle was fired in two 20-round bursts. One type of ammunition was fired in the first burst, and the other type was fired in the second burst, immediately following the first. In half of the rifles, Lot RA5060 was fired first, and in the remaining rifles this firing order was reversed... because it has been observed that, if two bursts are fired in rapid succession, the cyclic rate of the second burst is characteristically somewhat higher...This ..change, which occurs irrespectively of the ammunition variables, could thus be separated from the..comparison to be made.

Results

Rifles 1 - 26 (Lot 5060 fired first)	*Lot 5060 [CR8136]*	*Lot 5135 [WC846]*	*Difference*
Average rate, rds/min	*739*	*878*	*135*
Fraction exceeding 850 rds/min	*0*	*20/26*	
Rifles 27 - 52 (Lot 5135 fired first)			
Average rate, rds/min	*755*	*846*	*92*
Fraction exceeding 850 rds/min	*0*	*11/26*	

Observations

..Using [CR8136], both the mean cyclic rate and the standard deviation among rifles are..within the permissible limits of 650-850 rds/min...the statistical probability of exceeding these limits..is acceptably small.

In the case of [WC846]..both the mean cyclic rate and the standard deviation..are significantly increased..

Aside from the consideration of rejecting rifles..on grounds of cyclic rate...it is a matter of common experience that stresses are increased on reciprocating parts, and other parts subjected to impact loads, in any automatic weapon in which the cyclic rate is appreciably increased. It has been observed, and is to be expected from the mechanics of the problem, that fatigue failures of the bolt in the XM16E1 are somewhat more frequent when the cyclic rate..is significantly increased. The nature of the failure is, fortunately, not hazardous, but it necessitates somewhat more frequent replacement of bolts...There are also certain malfunctions which occur more frequently when the timing of the gun cycle is materially speeded up..

Conclusions

There is a clearly significant change in typical cyclic-rate performance of XM16E1 rifles, associated with a change in ammunition..[where] different types of propellant were employed.

Weapons which readily meet the present cyclic-rate requirement when using [CR8136] will frequently fail..when using [WC846]...For weapons such as those used in this experiment, none are likely to fail with [CR8136], whereas more than half are likely to fail with [WC846].

The difference in cyclic rate produced by ammunition differences is such that no controls which might be exercised over manufacture of XM16E1 rifles could guarantee compliance..the upper limit must be extended..to 1,000 rds/min to accommodate ammunition of both types.

The increase in cyclic rate..can be expected to reduce the endurance of certain parts (notably the bolt), and to increase the frequency of certain malfunctions (notably the failure of the bolt to latch rearward when magazine is empty)...a quantitative assessment of these effects is not yet available, because many thousands of rounds are necessary for rendering a statistically sound judgement on parts life and malfunction rate..

Thus the "bottom line" of Colt's Ammunition Variables report was that the cyclic rate of virtually all new XM16E1s was acceptable when tested with IMR-type powder, but that over half of these same rifles would exceed the limit and therefore be rejected if tested with ball propellant.

Other data was soon presented to support this conclusion. Ongoing SAWS reliability testing that same month had revealed "an unusually high number" of malfunctions. The PMO could pinpoint no known cause, although investigations were ordered. This general attitude of not looking for trouble, adopted by the Project Manager in order to safeguard the scheduled deliveries of rifles to the field, was nevertheless to have most unfortunate repercussions.

Later in November, the Combat Developments Command's Experimentation Center (CDCEC) reported encountering excessive cyclic rates, high malfunction rates and fouling when using 5.56mm ammunition loaded with ball powder during their portion of the SAWS trials. Again the obvious connection was stressed in CDCEC's report, but as the following excerpts show, Lt. Col. Yount persisted, in his orderly way, to deal with individual problems *in isolation*, and then only to the extent that was absolutely necessary:

Project: Rifles [week of] 20-24 December 1965

The..investigation..at Frankford Arsenal on 13 December.. [is] a result of the high malfunction rate obtained..during the SAWS Reliability test of XM16E1 rifles using..ball propellant. The purpose of the test is to determine the cause of the malfunction and..action required to provide a reliable.. weapons system.

The preliminary observations made during firing of 36,000 rounds.. (50% [WC846], 50% [CR8136]) in six tests is as follows:

1. A difference in characteristics..can be observed. A significantly higher cyclic rate is obtained with ball propellant. (75 -130 rpm).

2. There is an indication that cyclic rate is related to certain malfunctions.

3. Further observations are needed before conclusions can be reached regarding fouling; however, observations indicate more fouling when using ball propellant. No malfunctions attributable to fouling have been experienced in this test.

4. There is no immediate requirement for remedial action for the existing weapon/ammunition system currently in the field. However, there is a need to identify the technical problems related to the isolation of the interior ballistic differences, (IMR vs ball propellants) and to the modification of ammunition specifications to insure comparable performance with all approved propellant types..

General Besson Takes a Trip

Over the 1966 New Year the Commanding General of AMC took a trip to Vietnam to see for himself, among other things, just how the XM16E1 rifle was performing in combat. Significantly, he carried with him several hundred ruptured cartridge case extractors - 200 "of commercial design" and a further 200 designed for the 7.62 NATO case but modified for the smaller 5.56mm rim, there being no such item available through AMC supply channels.

General Besson embarked on his overseas trip with the PMR's final synopsis of Frankford's 36,000-round ball/IMR trial ringing in his ears:

..As noted in the last report, the preliminary findings.. indicate that any problems involved with the use of WC846 ball propellant are of a technical nature and should not be of concern to field units.

The increasing body of evidence linking ball powder to high cyclic rate and its attendant adversities came, ironically, on the very eve of the sharp step-up in production which answered General Westmoreland's call from Vietnam for 100,000 new XM16E1s. As the PMR reported for the week of 13-17 December 1965, "Colt's..has been requested to take any necessary action to accelerate production to a full production basis to meet greatly increased demand." All the available evidence on the ball powder problem was examined at the TCC's regularly scheduled meeting on 12-13 January 1966, where it was decided that, while warranting "correction", the stoppage rates were not high enough to be unacceptable in the field.

The Light Strike Problem - Redesigning the "Buffer"

While it was not as widely discussed, yet another problem inherent in the "fully developed" AR-15 had been discovered as early as 1963: misfires sometimes occurred, frequently during automatic fire, irrespective of the type of propellant used. Bill Davis explains:

..I obtained some information from [Springfield Armory] on the closing velocity of the AR-15 bolt during our investigation at Frankford..of the so-called "slamfire" problem [chapter 8]. When I went to Colt's..I found that they had, by then, also done some kinematic studies, which revealed that the cause of the misfires was the rebounding of the bolt carrier (which contains the firing pin) from its hard impact on the barrel extension, at the end of the counter-recoil stroke of the reciprocating parts.

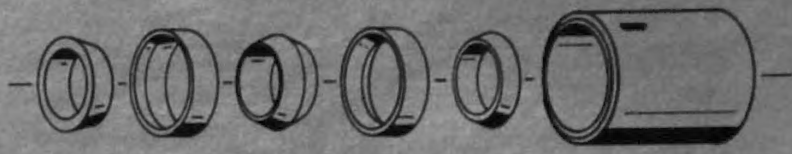
The timing of the carrier rebound, under certain conditions of weapon support, was such that it coincided with the falling of the hammer, and the bolt carrier was thus somewhat out-of-battery when the hammer struck. In that event, if the carrier was out of battery by more than about .020", the energy of the hammer was dissipated in driving the carrier forward, and was then insufficient to fire the primer.

Rob Roy, a key figure in the M16 project at Colt's, recalls that the "light strike" problem had been particularly bothersome during the development of the M1 and belt-fed M2 heavy-barrel (HBAR) versions of the CAR-15 system, so much so that prototypes of a number of different designs of "buffer" assemblies (officially called the "action spring guide assembly") were made up and tested, in an effort to reduce the carrier rebound.

The original AR-15 "action spring guide" had been designed to provide the required buffering action by means of a series of bevelled "Edgewater ring springs", which "gave" slightly when compressed. Interestingly enough, there had already been one modification to this component in July 1964, when Colt's had shortened its overall length by 3/32" in an attempt

..[They] did not work very well under the best of conditions, and often not at all under combat conditions in Southeast Asia..

In theory, the ring springs employed by Stoner were supposed to absorb the energy of the recoilling parts by a wedge-like principle, implemented by a series of male conical surfaces which mated with corresponding female surfaces, thus compressing diametrically the male cones and expanding the female cones upon axial compression of the assembly. The angle of the cones was calculated to be such that..they almost, but not quite, remained in their state of axial compression after impact of the recoilling parts upon the buffer..

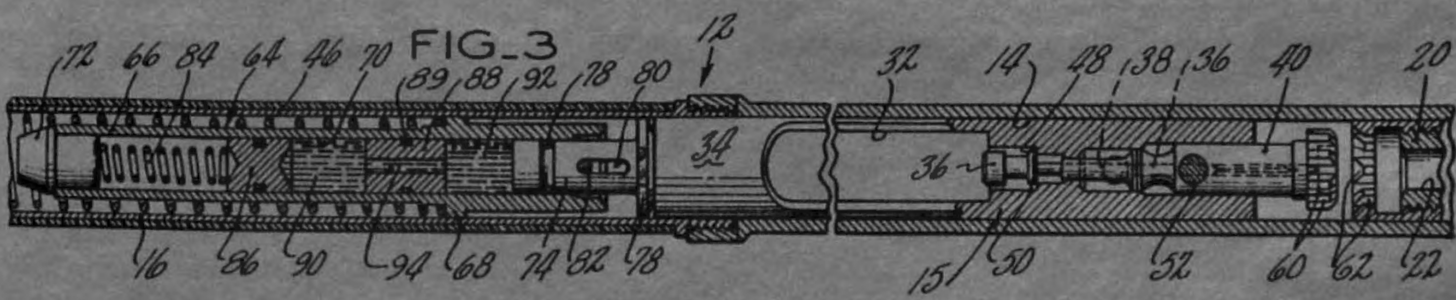


200. The components of the original AR-15 buffer, showing the "Edgewater ring springs" which were supposed to "give" on compression as described in the text. *Drawing by Thomas B. Dugelby*

to correct the chronic problem of last-round bolt catch failures when firing ammunition loaded with ball propellant.

Bill Davis comments further on a Colt analysis of the Edgewater ring springs:

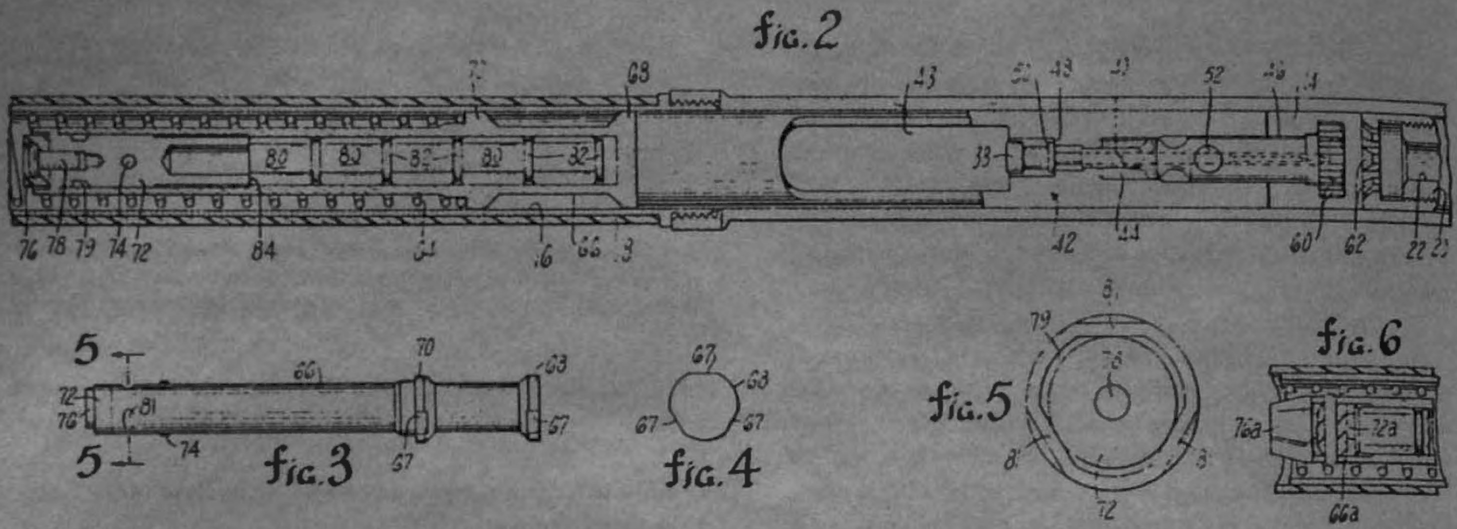
The flaw in this application..in a combat rifle was that the coefficient of friction..was not always the same, being dependent upon the degree of lubrication and/or contamination of the mating surfaces by oil, dust, mud or other such elements...If..too low, then the assembly acted much as an unrestricted spring and fed too much of the recoil energy back into the counter-recoil cycle. If the surfaces were contaminated by abrasive materials..then the frictional forces were too high, the ring springs failed to recover at all, and the assembly remained set in its state of full axial compression after the first impact, greatly increasing the impact load on the bottom of the tube, and thus transmitting the severe impact to..the rifle..in every subsequent cycle..



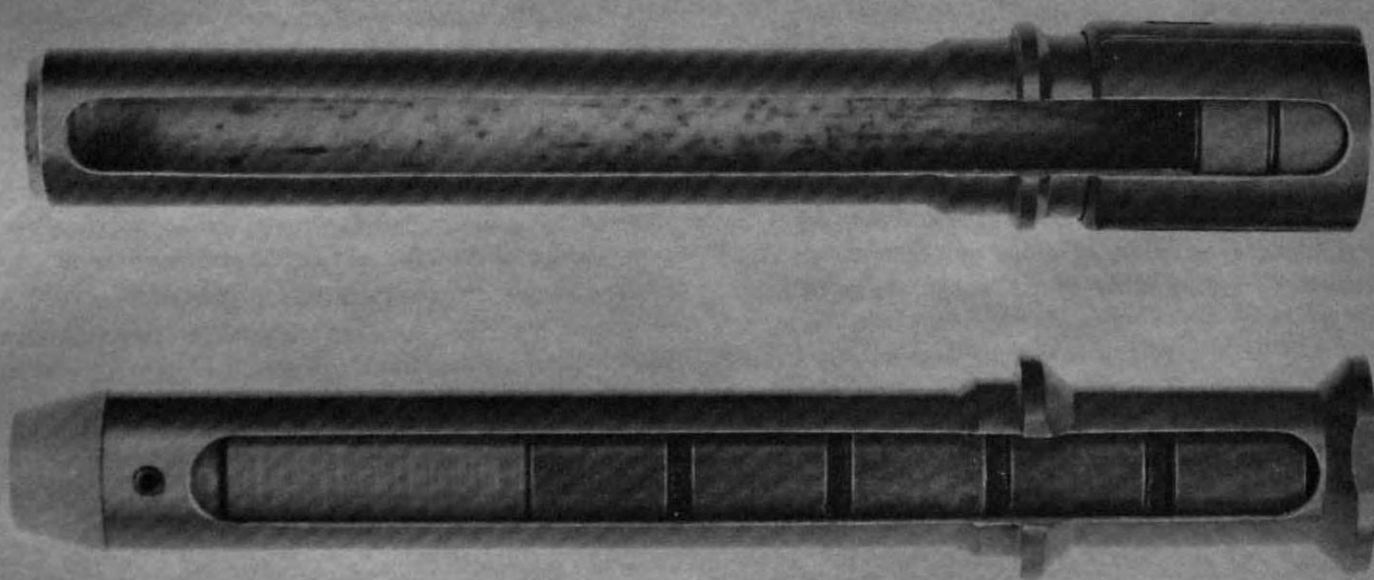
201. Fig. 3 from US Patent no. 3,977,296, Stanley D. Silsby's "Hydraulic Buffer Assembly for Automatic..Firearm", one of several attempts to solve the "light strike" problem. In this design, the hydraulic damping action is briefly described as follows: "When the piston 74 is moved inwardly toward the depressed position ..hydraulic fluid flows from chamber 92 to chamber 90 via the orifice 94... Releasing the inward force on the piston 74, results the seal pushing hydraulic fluid (under the urging of spring 84) through the orifice 94 from the chamber 90 to the chamber 92.." Not adopted. *US Patent Office*

At length the problem was solved by a new buffer designed by Colt's Chief Product Engineer, Foster Sturtevant. It was about three times heavier than the old guide, and replaced the troublesome aluminum ring springs with a polyurethane "bumper" on the end of the buffer tube to absorb recoil energy instead of feeding it back into the counter-recoiling parts, plus a series of five sliding internal weights separated by butyl rubber discs, whose purpose was to dampen bolt carrier rebound at the end of the counter-recoil stroke.

202. Another Colt model shop experiment: a solid nylon buffer, drilled out and fitted with a spring-loaded metal weight. As with the Silsby hydraulic buffer, this design was not entirely successful in damping bolt carrier "bounce" and thus solving the HBAR "light strike" problem. *Bob Miller collection*



203. Figs. 2 through 6 from US Patent no. 3,366,011 granted to Colt's Chief Product Engineer, Foster E. Sturtevant, self-explanatorily entitled "Buffer Assembly Having a Plurality of Inertial Masses Acting in Delayed Sequence to Oppose Bolt Rebound". A production-engineered version of Sturtevant's buffer (fig. 204) was adopted and installed in all new rifles beginning in December, 1966. The Army later reported that a retrofit program had replaced all the old "action spring guides" in service by the late fall of 1967.



204. Above: the original AR-15 "action spring guide", cutaway to show the internal "Edgewater ring springs".

Below: Colt's new buffer, which happily solved both the HBAR "light strike" problem and *the ball-powder-induced cyclic rate problem. Introduced in December, 1966.*

In the rifle, the new buffer did and did not do several things. First, because of the random position assumed at the end of each shot by the loosely-fitting internal weights and discs which comprised a large portion of the buffer's mass, the effect of the buffer's added weight on the rifle's "dwell time" or bolt-opening cycle was negligible.

Secondly, as mentioned, the polyurethane bumper cushioned the rearward impact of the recoiling parts, which also greatly reduced the incidence of the bolt catch failing to latch the bolt to the rear on firing the last round of a magazine. On the counter-recoil stroke, the weights and discs, pushed rearward inside the buffer body by the forward acceleration, "cascaded" forward when the carrier impacted against the barrel extension, in Bill Davis' words "imparting their individual momenta in turn" to the carrier, thus effectively damping or "killing" the carrier rebound.

Finally, the polyurethane bumper introduced a new phenomenon all its own: during burst fire, due to its low "coefficient of restitution", it retained some compression for the duration of the cycle, tending to become more resilient and thus cause the cyclic rate to progressively speed up: the longer the burst, the faster its cyclic rate.

As a happy aside, however, it was noted that in curing the HBAR light strike problem the heavier buffer also reduced the overall cyclic rate to the point of acceptability even when firing cartridges loaded with ball powder. At the January 1966 meeting Colt's introduced the new buffer to the TCC, proposing it as an across-the-board replacement for the old "recoil spring guide". The TCC welcomed the idea with enthusiasm, and ordered twelve new buffers made up for trial.

Springfield Armory ran a test of the new buffer from 13 April to 6 May 1966, concluding stubbornly that M16 performance using the new buffer and firing ball propellant, while now within the 850 rpm cyclic rate specification, was not as good as past recorded performance using the old action spring guide and firing ammunition loaded with IMR CR8136. In any case, the new buffer was subsequently adopted, first coming on stream in December 1966.

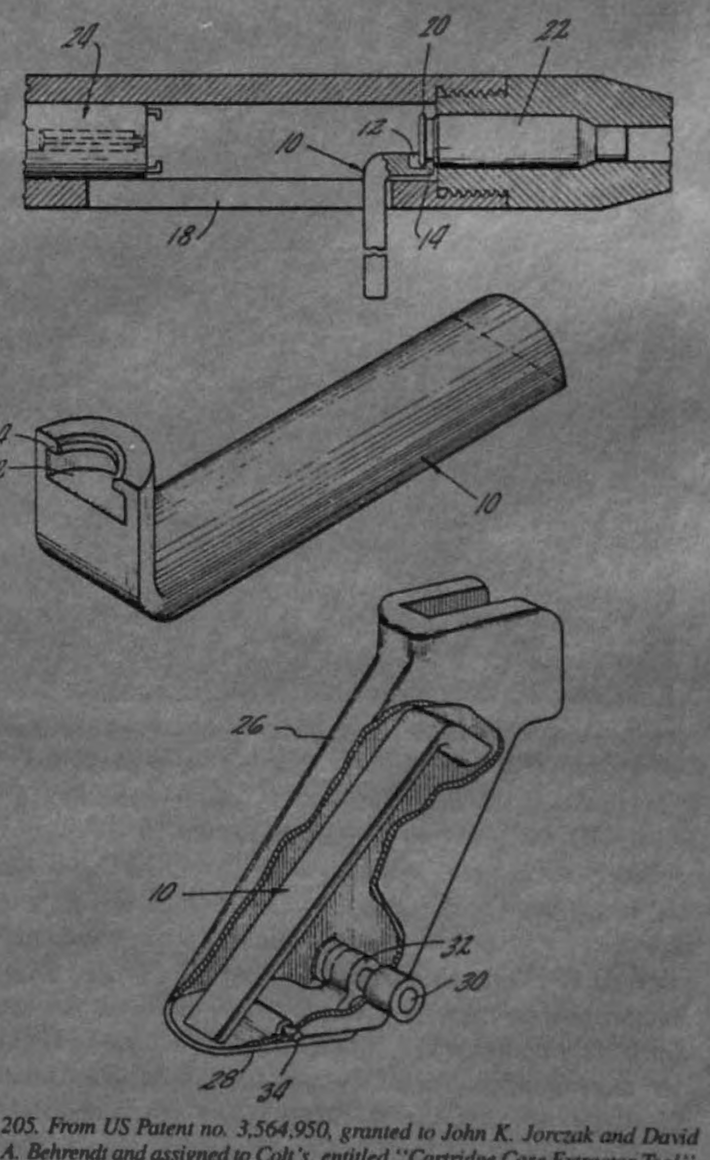
In a later statement, the Army explained the wisdom of replacing the buffer as a solution to the ball powder/cyclic rate problem as "modifying the rifle, rather than..altering ammunition specifications and, as a result, possibly degrading performance."

Foul Ball

With ball powder's characteristically heavier chamber fouling well documented but as yet unlinked to any major problems, the Project Manager reasoned that as soon as the new buffers were approved and introduced, the high cyclic rate problem would disappear, in effect leaving ball powder with a clean slate. Therefore, as later recorded in the February 1968 *Appraisal of the M16 Rifle Program* by the Director of Defense Research and Engineering (DDR&E), in order to ensure continued rifle acceptance and delivery, Lt. Col. Yount took it upon himself to pronounce the ball powder issue quietly closed:

> *..The Project Manager was responsible for furnishing Colt's with test ammunition. The cyclic rate phenomenon having been identified as a rifle-ammunition problem, which Colt's and the Committee expected to solve with a new buffer, the Project Manager decided to forego the use of WC846 for acceptance testing. He located all remaining lots of IMR [CR]8136-loaded ammunition and had them shipped to Colt's for use in future [XM16E1] testing. The effect was a* de facto *waiver of the Army's upper cyclic rate limit. The Air Force waiver to 900 rpm was still in effect. From March 1965 through September 1966 some 99 million rounds of M16 ammunition were consumed in Vietnam, 89 million of which were loaded with WC846, the balance with IMR [CR]8136.*.

Once again the PMR did not immediately inform General Besson of his actions. This fact was made obvious by the latter's comments pencilled on his copy of the significant action report for the week of 11-15 April 1966. Beside the announcement that the qualification of EX8208-4 (DuPont's third try at an acceptable 5.56mm propellant) would soon result in "competitive



205. From US Patent no. 3,564,950, granted to John K. Jorczak and David A. Behrendt and assigned to Colt's, entitled "Cartridge Case Extractor Tool". Note the proposed pistol grip trap, below, for stowage. US Patent Office

procurement'', General Besson had written ''What about [EX8208's] performance? What are we doing about the problem of fouling and high cyclic rate?''

In a special reply to AMC headquarters, the PMO admitted that ball powder did result in increased fouling, ''but not to an unacceptable degree.''

Colt's Historic Second Contract (DAAF03-66-C-0018) - The ''One-Time Buy'' is Dead

206. Signing the historic second contract (''0018'') in June of 1966. Left, seated: Colt's vice-president of marketing, William Goldbach. Center, signing: Firearms Division president Paul Benke. Far right, standing: military sales manager James B. Hall.

Since its reluctant acquisition in FY64, the Army had stuck resolutely to the idea that the XM16E1 was a ''one-time buy'' item for use by special units, and even then only until the SPIW became available. Maintaining this position had become increasingly difficult for a number of reasons. For one thing, as Lt. Col. Engle had pointed out, the USAF had officially adopted the M16 in a long-term program which the Army was committed to support. As for the Army itself, temporizing had resulted in a fits-and-starts approach to the XM16E1, a fact made very evident in the conduct of contract ''508''. In its lifetime, officially listed as from November 1963 to 24 January 1966, the ''one-time buy'' contract more than doubled in dollar value as a total of fifteen ''add-ons'' increased the number of rifles from the original 104,000 to 201,045.

This whole game was up in December 1965. General Westmoreland's victorious call for 100,000 new XM16E1s was the first incontrovertible crack in the concrete of the ''one-time buy'' philosophy.

Coincidentally, the July 1965 Air Force order for 36,682 M16s, which the PMR had estimated ''should extend Colt's production through April 1966'' had done just that. Certainly when that time did arrive, there was no more talk at Colt's of termination plans:

207. Colt's first attempt at a handguard made of interchangeable, rounded top-and-bottom halves, circa 1965-66. Note the round front bracket. Although less bulky than the non-interchangeable left-and-right handguards (top), the idea was not generally adopted until the M16A2 program (chapter 22).

Project: Rifles [week of] 28 March - 1 April 1966

M16/XM16E1 rifle program: *Program authority has been received to proceed with the procurement of 403,905 XM16E1 rifles as reflected in the January FY66 budget supplement. In addition, a teletype Military Interdepartmental Purchase Request (MIPR) for 15,372..XM16E1 rifles has been received from the Marine Corps. This will bring the total procurement action to 419,277..rifles, as follows:*

Army	*213,405 (100,000 of this amount is currently on letter contract)*
VN MAP	*114,000 [Military Assistance Plan]*
Marine Corps	*91,872 (76,500 contained in FY66..Budget Supplement)*
Total	*419,277*

Contract "0018" was duly signed in June 1966. It was history-making for several reasons, one being that its very existence meant the end of the blinkered "one-time buy" mentality regarding the M16. Also, it was with the September 1966 issue of new XM16E1s made under contract "0018" to regular US Army units in Vietnam that the real troubles began, as we shall see.

Meanwhile, as regards the contract, here as before "add-ons" were frequently employed. Contract "0018" was amended a total of 256 times during its lifetime, which was from June 1966 to a final ahead-of-schedule delivery of 13,360 rifles (down from a peak of 45,000 per month at Colt's on this contract alone) in January 1969.

Contract "0018" was later summed up by AWC's Cost and Economic Information Division in their *Procurement History and Analysis of M16 Rifle* of August 1971 as follows:

..A negotiated contract based upon a firm-fixed price (FFP) was signed with Colt's Inc. on 16 June 1966 for a price of $45,035,407.50. This definitized contract was Mod. 13 of letter contract dated 6 December 1965.

..This contract was for the procurement of 403,905 each XM16E1 rifles with seven (7) twenty round aluminum magazine assemblies and bipod.

..Modifications to the contract increased the contract price by $46,646,752.35 to a total of $91,682,159.88 while increasing the quantity of rifles from 403,905 to 836,810..

The Singapore Caper

In the midst of the issue of XM16E1s to US Army maneuver units operating in Vietnam, Colt's received permission from the State Department to export 20,300 rifles, (18,000 commercially-marked AR-15s identical to the Air Force's selective fire M16, and 2,300 HBAR [heavy barrel] AR-15s), to the government of the Republic of Singapore. Having split away from the newly-

formed Federation of Malaysia in mid-1965, the prosperous city-state of Singapore subsequently instituted its own defense policies. Representatives of the Singapore Armed Forces had then come calling at Colt's for some of the rifles which were well remembered from the days of Bobby Macdonald's world tour.

The Defense Department had long held the view that "open-ended" foreign sales of the AR-15 were "not in the best interest of the United States". (At Colt's, this position was viewed as an unfair and unnatural stranglehold on their proprietary product. Indeed, as Colt executive James B. Hall noted above in his remarks about General Westmoreland's 100,000 rifles, it was "an extremely political situation"). Ignoring the Defense Department's objections, the Office of Munitions Control in the State Department decided that in this case "the purchase fulfilled a normal requirement for the Republic of Singapore and was in our national interest". They accordingly approved the export license without bothering to inform the Army.

At this time Colt's was producing XM16E1 rifles in response to contract "0018", which called for them to reach a rate of 25,000 units per month by December 1966. Colt's proposed to increase this quota to 27,500 rifles per month, thereby spreading the $3,415,333.18 Singapore order over an 18-month period from March 1967 to September 1968 without any disruption of regular Army delivery schedules. Although Defense officials later closed ranks around the position that they were then accepting all the rifles the system could absorb, the Army was as we shall see already examining detailed plans to secure the manufacturing rights to the design of the rifle and establish a second source of supply, all with a determined view to yet another massive increase in production.

This essential contradiction mystified several Congressmen, including Missouri Democrat Richard Ichord and Illinois Republican Paul Findley. (Indeed, during the course of the later Ichord subcommittee investigation, after fruitlessly putting numerous pointed questions to Dr. Robert Brooks, the Assistant Secretary of the Army for Logistics, Mr. Ichord commented that "..there certainly seems to be a defect in the procedures. I would think that a rifle that apparently was in great demand by our Armed Forces in South Vietnam - that it would be of the greatest importance that DOD have an intense interest in such a sale, even greater than the State Department".)

Others also had an intense interest in the AR-15. By June of 1965 there were 19,750 "Free World" troops allied with the US and ARVN soldiers in Vietnam, including the 1st Battalion of the Royal Australian Regiment, an ANZAC battalion and Thai, Philippine and ROK (Republic of Korea) forces. The latter three were armed with American M1 rifles. As soon as news of the Singapore sale became known, the Koreans bitterly and graphically denounced it, feeling with much justification that if there were any "spare" M16s, they wanted to be fighting with them, and not watching them be sold elsewhere.

Ironically, after all this furor Colt's delivered only some 3,000 to 3,500 US-built rifles on the Singapore contract. In February 1967, the government of Singapore negotiated an agreement with Colt's that permitted the licensed production of 150,000 M16 rifles in Singapore itself. This is discussed in chapter 21.

Ominous News from the IRUS Program

Meanwhile, the US Army Combat Developments Command (CDC) had announced its new Infantry Rifle Unit Study (IRUS). This field project was an offshoot of the ongoing SAWS program, wherein XM16E1s, SPIWs, and other types of small caliber weapons were compared in simulated combat environments at CDC's Experimentation Center (CDCEC) at Fort Ord, California. The Project Manager listed in his weekly report for 25-29 April 1966 some of CDC's "specific materiel requirements" as including "14 AAI SPIW weapon systems plus 150,000 rounds of [XM645] SPIW ammunition.."

After a briefing on the IRUS project in April, General Besson had queried the (newly-promoted) Col. Yount's oft-used weekly wrapup "There are no continuing problems to report" by asking uneasily, "Is everybody happy? CDCEC didn't seem to be." By June, the IRUS program had run into a serious difficulty:

Project: Rifles [week of] 6-10 June 1966

M16/XM16E1 Program: *A malfunction of a XM16E1 rifle/5.56mm ammunition system occurred on 3 June..during the IRUS program. It was reported that a cartridge case-head had ruptured resulting in extensive damage to the weapon and minor injury to the shooter. This is the third such incident reported since the inception of the M16/XM16E1 rifle program...On-site investigation..was conducted..by.. Frankford Arsenal, the ammunition contractor (Federal Cartridge Co.), and the PMO.*

Regarding the rifle in question, it was found that, while "severely damaged", the bolt-to-barrel-extension lockup had withstood the force of what appeared to be an overpressure explosion. No fault could be found with the weapon or personnel involved, but further use of Federal Cartridge Co.'s entire offending lot FC1830 of M193 ammunition was immediately suspended, along with the next complete lot in sequence, FC1831. Frankford proceeded to investigate and write up a report on the ammunition from the cartridge case hardness standpoint, yet another parameter which had been ignored by the TCC up to this time. Indeed, as early as 1964 Frankford had warned that case hardness was "a significant factor in AR-15 functioning", and had recommended the establishment of 5.56mm case hardness specifications and controls. True to his mandate, however, Col. Yount had pragmatically decided that in the absence of any related malfunction reports there was no need to establish such controls.

That might have been the end of it, except the same thing happened again for a fourth time on July 8th. Again the rifle held together and the shooter was not seriously injured, and again the ammunition lot, this time Remington's lot no. 5189, was suspended. In spite of General Besson's pencilled "Don't spare any effort to get at the solution to this problem" the subsequent investigation, discussed in chapter 13, ultimately failed to discover the cause of these first in a series of occasional 5.56mm blowups which have inexplicably occurred over the past two decades.

Early Problems in Vietnam

Fresh from a June 24 meeting at Fort Benning, General Besson fired off a terse memo to Col. Yount:

Vietnam returnees complained of separation of rims on extraction. What do we know about this?

There is no recorded reply. Throughout the summer of 1966, as new XM16E1s were being issued to all the US Army's maneuver battalions in Vietnam, the PMR's weekly significant action reports all concluded the same way: "There are no continuing problems to report."

208. The general-issue XM16E1 amid the "unbelievable" combat conditions of Vietnam. Note the cleaning rod, taped onto the rear rifle leaning against the tree.

Chapter Thirteen

THE FIT HITS THE SHAN

..There is no doubt that some arms..failed to function when fired rapidly which was due to the softness of the ..shell casing...Powder residue, gases and grease did foul the receivers. The..steel, expanding rapidly upon heating, literally welded the empty shell cases to the chamber. When ejection was attempted, the extractor cut through the..rim of the shell or jumped the rim entirely. The employment of a ramrod was the only sensible aid to be used in dislodging the shell and cleaning rods were [in short supply]. Prying the shell out..was a slow procedure... Recommended remedial action was almost pathetic...To attempt to close the..breech on a shell casing which the extractor had jumped was a "recruit trick" which only served to further impair the already sprung extractor and further jam the shell casing. And jamming, if one can accept the contemporary comments, was constant..

As it happens, these bitter words are not about Vietnam. They are excerpted from the excellent booklet *The Trap-Door Springfield in the Service*, by Col. Philip M. Shockley, and are describing events of over 100 years ago concerning the 1873 Springfield trap-door carbine and the soft, copper-cased .45-70 cartridges of that era. In the fall of 1966, their coincidental and sadly timeless ring of truth would have brought cold comfort indeed to a very busy Col. Yount.

As mentioned, the first XM16E1 rifles made under the new FY66 contract ("0018") had begun to arrive in Vietnam during the summer of 1966, with issue to all US Army maneuver units being completed by late fall. Almost immediately the troops were reporting excessive stoppages and malfunctions:

Project: Rifles [week of] 3-7 October, 1966

M16/XM16E1 rifle program: *A letter from the Commanding Officer of the 1st Battalion, 2nd Infantry, 1st Infantry Division indicates that his unit has experienced many problems with the XM16E1 rifle...Telephonic reports from Vietnam indicate that these rifle problems are prevalent in other units..to the extent that confidence in the weapon is being degraded. This office is formulating plans to send representatives of the [PMO], WECOM and Colt's Inc., to Vietnam to resolve the problems..*

Project: Rifles [week of] 10-14 October 1966

M16/XM16E1 rifle: *In response to request from this office reference stoppages and malfunctions being experienced on the XM16E1 rifle by subordinate units in USARV, [General Westmoreland] officially requested technical assistance...The message also indicated the existence of a training and maintenance problem, and requested a team be sent to Vietnam to conduct a training program and to initiate an inspection and maintenance program. [Lt. Col. Underwood, Col. Yount's assistant and leader of the team] departed for Vietnam 13 October; with the remainder of the six-man team (three representing [the PMO and WECOM] and three representing Colt's Inc.) to depart on/about 20 October. Necessary repair parts and tools will accompany the team. The anticipated duration of the visit is approximately 30 - 45 days.*

In testimony before the Ichord subcommittee in the House of Representatives the following summer, Col. Yount recalled the events of the next few weeks:

209. *With his helmet as a catchall, a GI cleans his XM16E1 as best he can. Note the shaving brush next to the oil can on the driver's seat.*
Black Star photo by James Pickerell

..[Lt. Col. Underwood] called me on the telephone and told me that he would advise me to come over here and see this for myself, because when he came home he didn't think he would be able to convince me of the conditions, of the various things that we would have to do to correct the situation..

..So I did see a number of weapons over in Vietnam. I talked with the various commanders there, including General Westmoreland, and was trying to get a feel on what was happening over there. And it appeared at that time that the majority of the trouble [concerned] a lack of proper maintenance and cleaning. However, there were some product improvements that might be made that would assist the soldiers in the field so that [the XM16E1] would not be so difficult to maintain..

Following Col. Yount's return to Rock Island on 29 November, there was a significant addition to his usual "There are no continuing problems to report". Henceforth certain of the PMR's weekly significant action reports carried the following footnote:

No secondary distribution will be made at the project manager level or in-house AMC activities. The report must not be reproduced, filed, or referenced in any official correspondence. Only the originating PM and the SA-PM, HQ USAMC may retain file copies of the report. All other copies will be destroyed within 10 days of receipt.

210. *The final step: a good going-over with some LSA and that non-standard shaving brush, useless as regards the critical chamber/barrel extension area.*
Black Star photo by James Pickerell

One of Colt's three experts in the PMO team sent to Vietnam was Kanemitsu "Koni" Ito, a decorated veteran of the Korean war who before joining Colt's had been a US Army test officer for twelve years, mostly with the Arctic Test Board in Alaska. As such he had been familiar with the AR-15 since Gene Stoner's first presentation at Fort Greely back in 1956.

..During the first trip..I was shocked. I never had seen equipment with such poor maintenance.

We did our utmost at every base camp, giving classes in first, second and third echelon. We travelled throughout every portion of Vietnam, except the Marines [who didn't as yet have any XM16E1s "in-country"] and Air Force [who continued to report excellent performance from their M16s]..

..I spoke to many enlisted personnel as to why they did not maintain their rifles. Some of them didn't know how. Many of them said they were never taught the maintenance of this rifle, or had not seen this rifle until they had arrived in Vietnam.

..I asked to look at [one] squad's rifles. Some you could not see daylight through the barrel. The barrels were rusted, and the chambers were rusty and pitted...I asked what the platoon had done upon their return [from patrol], oh, [the squad leader] said, we rested until the next one.

I said, "No, I mean what did you do to clean the rifle?" He said, "Nothing".

All in all Mr. Ito made three trips to Vietnam, finding the weapons, especially the first time, in an "unbelievable" state of repair. Especially on this first trip, he confirmed the dearth of cleaning materials and proper information regarding maintenance. He later described his findings to the Ichord subcommittee:

Saved by the Buffer?

Lt. Col. Underwood had also confirmed that while in Vietnam his team had examined numerous rifles wherein the "ring springs" of the old-style recoil spring guide were wedged tightly together, the assembly behaving exactly as if it were made of solid aluminum. Happily, Colt's new buffer came on stream as standard equipment in all new rifles beginning with the 18,400 XM16E1s manufactured in the latter part of December 1966. At the same time, a retrofit program was begun, at an agreed price of $2.75 apiece, to replace the old "recoil spring guides" in all existing rifles. A later PMR report summed up:

Buffer Retrofit Program for M16/XM16E1 Rifles

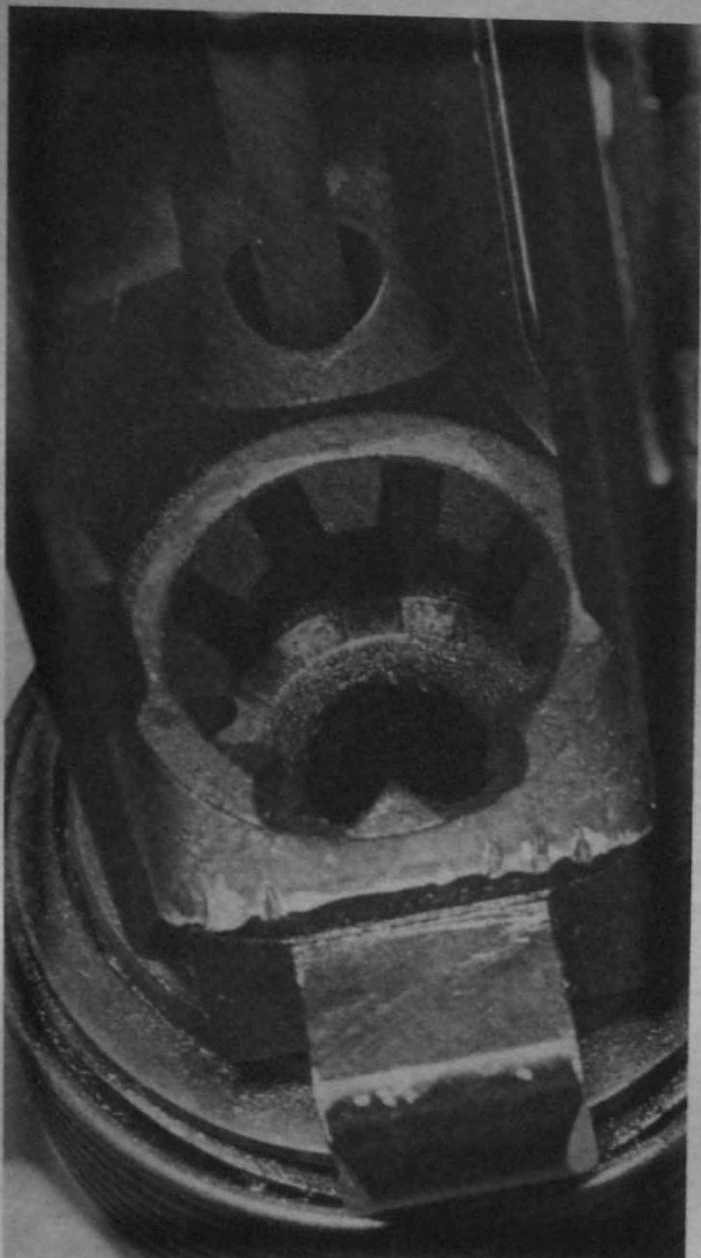
11 August 1967

Total rifles produced with old buffer (includes all services)	*357,935 (to December 1966)*
Known losses through Mar 67	*1,755*
Total for Retrofit	*356,180*
New Buffers already on procurement	*222,692*
Balance needed to complete retrofit	*133,488*

The Army later announced that the buffer retrofit program had been successfully completed by late fall, 1967.

Meanwhile, acceptance test records at Colt's began to bear out the efficacy of the new buffer. Under the terms of contract "0018", one rifle chosen at random out of every 10,000-rifle lot was routinely subjected to a 6,000-round endurance/acceptance test. From May to December of 1966, 91,000 rounds loaded with CR8136 had been fired in rifles with old buffers, with an overall malfunction rate of 0.49 per 1,000 rounds. From December 1966 to June 1967, 102,000 rounds loaded with WC846 were fired in rifles fitted with new buffers for an average malfunction rate of only 0.25/1,000 rounds.

Nevertheless, the new buffer was seen by many as nothing more than a belated and expensive Army "field fix" for the too-high cyclic rates produced by ball powder. As we have seen, this was decidedly not the whole truth, but the story persisted: OSD saw potential embarrassment in any discussion of the main reason for the buffer redesign, which was the carrier rebound/light strike problem inherent in the original "fully developed" recoil spring guide.



211. Left: closeup of the barrel extension and chamber from a "problematic" XM16E1 returned from Vietnam for study. Note the dark, corroded chamber wall. Right: a new XM16E1 following a 10,000-round WECOM endurance trial in October, 1966. Note that although the receiver, barrel extension and handguard slip ring are all caked liberally with powder residues, the chamber walls appear comparatively clean and shiny.

The PMR Comes Clean

In December 1966, as soon as the tale could be told without compromising the XM16E1 acceptance rate, Col. Yount informed General Besson that acceptance testing at Colt's had for the last seven months been done exclusively with ammunition loaded with IMR CR8136 propellant. As expected, the immediate reply from AMC headquarters was an order to reintroduce ball-powder test ammunition as quickly as possible. By that time all of Colt's new rifles were fitted with the heavier buffer, which corrected the unacceptably high cyclic rates produced by ball powder's higher port pressures.

The Unsolved Mystery of CDCEC's Ruptured Cartridge Cases

Frankford and Rock Island Arsenals had meanwhile been busy trying to duplicate CDCEC's summer 1966 reports of blown cases, which as mentioned had occurred at Fort Ord during the IRUS program. The following is the PMR's interesting account of the enigma which still remained:

Project: Rifles [week of] 19-23 December 1966

..Exhaustive tests of all ammunition characteristics were conducted and these were supplemented with theoretical studies of interior-ballistic parameters, spectrochemical analysis of combustion residue in the ruptured cartridge cases, and metallurgical examination of the ammunition metal parts and related weapon parts. None of these tests indicated any possible cause for the reported malfunctions or gave any clue as to their explanation.

A series of tests was conducted where attempts were made to simulate the malfunctions observed at CDCEC. Propellants were varied in type and amount; primers were altered in composition and pellet weight; various firing conditions were imposed; etc...it was found that the malfunction could be reproduced only through the use of a clearly unsuitable propellant type such as pistol..or shotshell powder, but there is no evidence or reason to suspect that propellants of this type were involved in the CDCEC malfunctions.

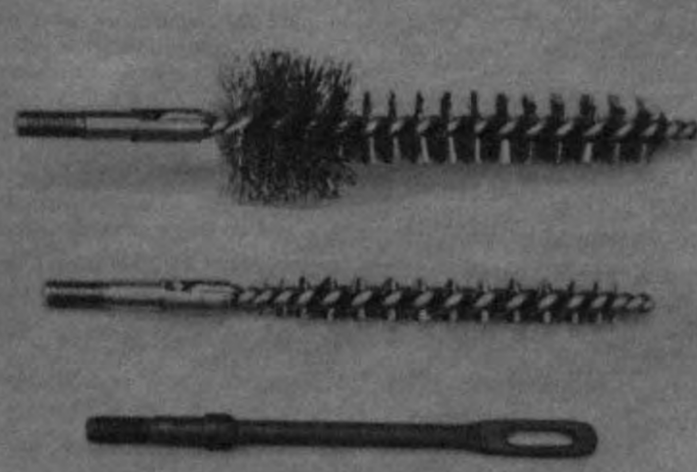
It is also well known that bore obstructions can cause chamber pressures of sufficient magnitude to rupture the head of a cartridge case. One report has been received from USARV where an attempt was made to fire a tracer cartridge with a cleaning rod in the bore...USARV also reported [that] four weapons "blew up" during a firefight which occurred immediately following the fording of a deep stream...In each of these incidents, the weapon damage was similar to that observed at CDCEC..

The study concluded that the malfunctions reported by CDCEC must be attributed to abnormally high pressures, the cause of which remains unknown and cannot be established from the evidence presently available...An extensive survey of CONUS Army and Air Force installations revealed that no other instances of this malfunction have been recorded in firing of 55,259,900 ball..and 1,292,400 tracer cartridges..

As mentioned in chapter 12 these incidents were the first in a series of fortunately very isolated cases which have occurred, and remain unexplained, over the past twenty years. The pressures attained are usually in excess of 125,000 psi, yet a 5.56mm case *packed full* of its regular powder does not even qualify as a standard *proof* load. (To attain the stipulated proof pressure of 70,000 psi, issue proof rounds are loaded with a hefty charge of Unique pistol powder.) Conversely, a round *without* much or any powder charge could lodge its bullet as an obstruction which might well cause a blowup on firing the next round, but in the unexplained overpressure incidents there is generally no evidence of rings or bulges in the barrel!

The Cleanup Begins

Col. Yount and his staff were quite busy over the 1967 New Year holiday. The following excerpts from a special memorandum prepared at General Besson's request provide an indication of the status of 5.56mm cleaning equipment in Vietnam, six months after general issue of the XM16E1 rifle system had begun:



212. Three key tools in the fight to keep the XM16E1s functioning in the field. Above: the long-awaited Chamber Brush, first shipped to Vietnam in late 1966 with monthly production accelerating to 120,000/month. However, as noted by Col. Crossman, this "critical" item was still in short supply in June of 1967. Center: the improved .22 caliber Bore Brush. Production accelerated to 280,000/month in April, 1967. Below: the Swab Holder (all fit the new, 4-section M11E3 Cleaning Rod.

Cleaning Materiel for the XM16E1 Rifle

13 January 1967

..In general, status of each item is:

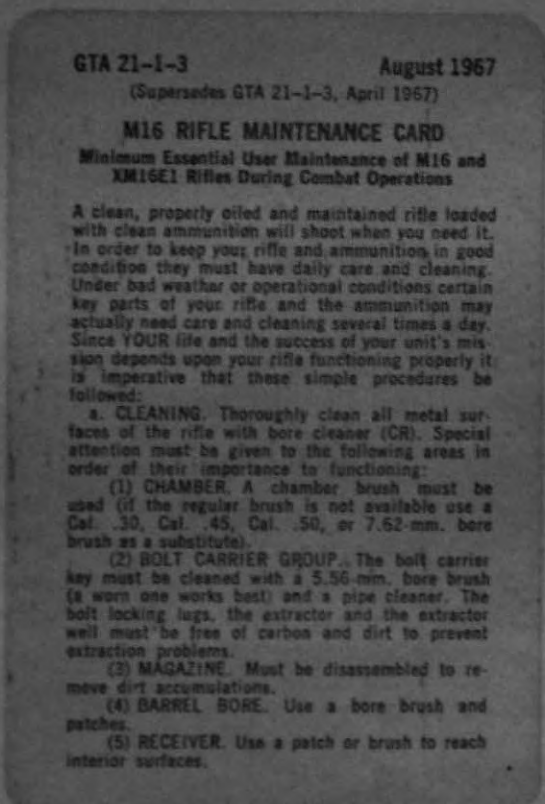
Swabs: ..urgent requirement for 55,000 packages and monthly requirement for 18,650 packages...Contractor will deliver 12,000 packages per week beginning 15 February. Immediate problem resolved.

Brush, bore: ..urgent requirement of 23,000 exists, with monthly requirement of 12,000. Thirty-five thousand (35,000) will be shipped in January...In April, production will accelerate to 280,000 per month until total requirements are satisfied..

Chamber brush: ..urgent requirement for 38,000 exists with monthly requirement of 25,000. Ninety thousand (90,000) will be shipped this month, and 120,000 a month thereafter until total requirements are met..

Cleaning rod: ..urgent requirement for 48,187..with monthly requirement of 12,000...31,000 will be shipped in January.. 39,000 in February, and 22,000 in March.

Every possible expediting action is being taken to provide the XM16E1 rifle cleaning items to USARV..



GTA 21-1-3 August 1967
(Supersedes GTA 21-1-3, April 1967)

M16 RIFLE MAINTENANCE CARD

Minimum Essential User Maintenance of M16 and XM16E1 Rifles During Combat Operations

A clean, properly oiled and maintained rifle loaded with clean ammunition will shoot when you need it. In order to keep your rifle and ammunition in good condition they must have daily care and cleaning. Under bad weather or operational conditions certain key parts of your rifle and the ammunition may actually need care and cleaning several times a day. Since YOUR life and the success of your unit's mission depends upon your rifle functioning properly it is imperative that these simple procedures be followed:

a. CLEANING. Thoroughly clean all metal surfaces of the rifle with bore cleaner (CR). Special attention must be given to the following areas in order of their importance to functioning:

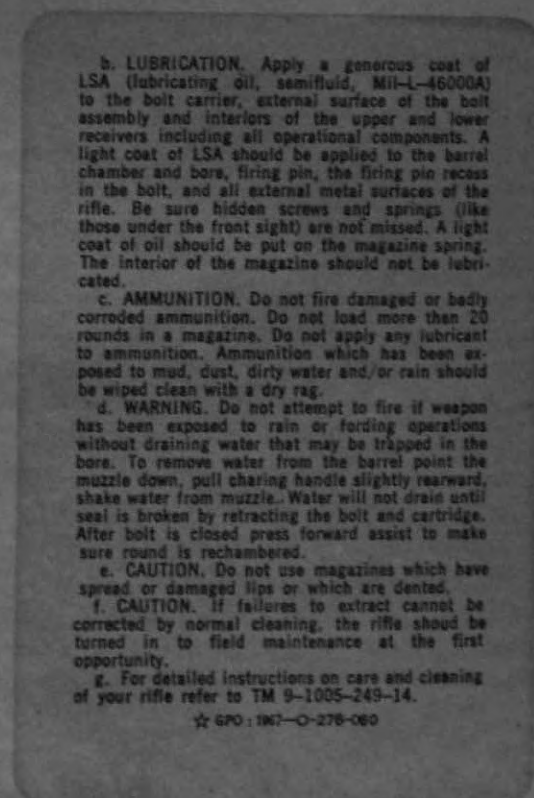
(1) CHAMBER. A chamber brush must be used (if the regular brush is not available use a Cal. .30, Cal. .45, Cal. .50, or 7.62-mm. bore brush as a substitute).

(2) BOLT CARRIER GROUP. The bolt carrier key must be cleaned with a 5.56-mm. bore brush (a worn one works best) and a pipe cleaner. The bolt locking lugs, the extractor and the extractor well must be free of carbon and dirt to prevent extraction problems.

(3) MAGAZINE. Must be disassembled to remove dirt accumulations.

(4) BARREL BORE. Use a bore brush and patches.

(5) RECEIVER. Use a patch or brush to reach interior surfaces.



b. LUBRICATION. Apply a generous coat of LSA (lubricating oil, semifluid, Mil-L-46000A) to the bolt carrier, external surface of the bolt assembly and interiors of the upper and lower receivers including all operational components. A light coat of LSA should be applied to the barrel chamber and bore, firing pin, the firing pin recess in the bolt, and all external metal surfaces of the rifle. Be sure hidden screws and springs (like those under the front sight) are not missed. A light coat of oil should be put on the magazine spring. The interior of the magazine should not be lubricated.

c. AMMUNITION. Do not fire damaged or badly corroded ammunition. Do not load more than 20 rounds in a magazine. Do not apply any lubricant to ammunition. Ammunition which has been exposed to mud, dust, dirty water and/or rain should be wiped clean with a dry rag.

d. WARNING. Do not attempt to fire if weapon has been exposed to rain or fording operations without draining water that may be trapped in the bore. To remove water from the barrel point the muzzle down, pull charing handle slightly rearward, shake water from muzzle. Water will not drain until seal is broken by retracting the bolt and cartridge. After bolt is closed press forward assist to make sure round is rechambered.

e. CAUTION. Do not use magazines which have spread or damaged lips or which are dented.

f. CAUTION. If failures to extract cannot be corrected by normal cleaning, the rifle shoud be turned in to field maintenance at the first opportunity.

g. For detailed instructions on care and cleaning of your rifle refer to TM 9-1005-249-14.

☆ GPO : 1967—O-278-060

213. The hastily-issued, playing card-sized M16 Rifle Maintenance Card: a much heavier emphasis on rifle cleaning and maintainance than Colt's had originally recommended (chapter 4). Actual size. Courtesy James Alley

Despite these tardy efforts to come to grips with the issue of XM16E1 maintenance, it appears that by this time Col. Yount was some distance from his superiors' good graces. His significant action report for the week of 16-20 January 1967 contained only the words "A negative report is submitted for this period." This was apparently too much for General Besson, whose pencilled scrawl to Col. Yount's attention ended, "You are long overdue in getting this situation in hand".

The M16A1 - A Troublesome Standard 'A'

Amid this state of affairs, the XM16E1 rifle was officially type classified as Standard 'A' by the Department of the Army on 28 February, 1967, henceforth to be known as "US Rifle, 5.56mm, M16A1". Traditionally, dropping the earlier 'T' (Test) or current 'X' (Experimental) designation signalled the US Army's final acceptance of a fully-engineered item, ready for issue. Ironically, in the case of the M16A1 rifle, the occasion was greeted by the PMR's March 13-17 report of ongoing investigations into problems uncovered in Vietnam under the following seven topic headings:

1. *alternate propellants*
2. *high cyclic rate*
3. *chamber corrosion*
4. *barrel twist*
5. *fouling experience*
6. *tracer requirements*
7. *product improvements*

The Crossman Report

As discussed below, the Ichord congressional subcommittee began its much-publicized investigation into the conduct of the M16 rifle program in May of 1967. One of the subcommittee's first requirements was a reliable, *independent* report on conditions as they actually existed in the combat zones. To this end Col. E. B. "Jim" Crossman, recently retired and hitherto very much involved in Army weapon and ammunition programs, was requested to go to Vietnam and report back to the subcommittee.

Col. Crossman's *Report of Investigation of M16 Rifle in Combat*, dated 16 June 1967, was a record of discussions with over 250 men in both Army and Marine units scattered widely across Vietnam. About 50% of these had encountered serious malfunctions with their XM16E1s. Col. Crossman estimated that approximately 90% of these malfunctions were failures to extract, surely as serious a problem in 1967 as it had been in 1873. Although time did not allow a detailed comparison of the M16's malfunctioning rate with that of the M14 rifle, the general feeling was that the M14 was markedly superior in reliability. Even with its extra weight and recoil, about 50% of the men questioned said that they would prefer the M14.

Regarding the M16, there had been relatively few failures to feed, but there were many reports of a stuck or frozen selector lever. Col. Crossman reported that while he saw no shortage of general cleaning and preserving equipment, many individuals were lacking the "critical" .22 caliber cleaning rod and chamber brush. Interestingly, very few cases of rusty chambers were found. As regards lubrication, Col. Crossman noted many different methods in use, but reported that none could be correlated with malfunctions. In addition, "..It was not possible to correlate ammunition make or type with malfunctions."

The June 1967 Crossman report to the Ichord subcommittee ended with the sweeping recommendation that:

> *An immediate investigation be conducted of ammunition design, ammunition manufacture, rifle design, rifle manufacture, and maintenance in the field in Vietnam in order to determine the cause of, and the cure for, failures to extract.*

> *..Consideration be given to permitting the combat soldier in Vietnam to choose the M16 or the M14 rifle.*

Onward, Yountless

And so, in spite of repeated urgings from General Besson and from the field, and a full year after setting out to arm all US maneuver units in Vietnam with XM16E1/M16A1 rifles, the maintenance situation was by all accounts still woefully inadequate. Particularly sad was the shortage of 5.56mm cleaning rods and the fact that chamber brushes had only appeared as an item of issue the previous March and were still in short supply. In addition, some of the changes introduced into the rifle/ammunition system since the TCC took over in 1963 were now known to have produced or contributed to further problems, which the lack of maintenance could only exacerbate. Worse still was the growing fear that, as Col. Crossman implied, the chronic (90% of all malfunctions) failure-to-extract problem could not be wholly attributed to lack of maintenance or indeed to any one single cause.

In sum, after four years of TCC "improvement", the rifle that Bobby Macdonald had taken around the world to universal acclaim now stood, in Col. Crossman's opinion, in need of a complete overhaul both in design and method of manufacture.

In the popular view this state of affairs was the fault of the Army, the service members of the TCC, and in particular the Project Manager. However, in Bill Davis' personal assessment, the initial, mistaken assumption on the part of OSD in 1963 that the AR-15 could be procured in quantity with little or no further engineering development was the root of the problem.:

> *..While Stoner's design was excellent, there had been no significant engineering development of it before 1958, notwithstanding the various subsequent claims to the contrary. Indeed none of the parties who had custody of the design before 1958, or..afterward until its procurement was undertaken by the Army in 1963, had the facilities required for an adequate program of engineering development and necessary testing. In fact they had little appreciation of the* necessity *for adequate engineering development and testing of military weapons, as was demonstrated by some of the absurdities uttered years later, and duly applauded, in testimony during the congressional investigation..*
>
> *Shooting watermelons at a picnic does not constitute adequate engineering testing, and a round-the-world junket to present sales demonstrations to the military aides of various potentates does not establish that a weapon system has been adequately developed for serious military deployment.*

On July 25 1967, the project manager who had only two years earlier been hailed as "the most important..to the Infantry" described his current status to the Ichord subcommittee as "Casual en route to Korea at the present time.."

214. To bring the absolute necessity of proper rifle maintenance home to the troops, the famous comic artist Will Eisner, of Mad *Magazine fame, was pressed into service to illustrate several editions of this down-home style M16A1 Operation and Preventive Maintenance booklet (DA Pam 750-30). On page 1, ("how to STRIP your baby"), the M16A1 is described as "your dearest next o'skin - bar none!"*

The Ichord Investigation of the M16 Rifle Program

On May 3 1967, one month before the announcement of Col. Yount's demise as Project Manager Rifles, the chairman of the US House of Representatives Armed Services Committee had appointed Richard Ichord to chair a special three-man subcommittee, the purpose of which was "to make inquiry into the development, production, distribution and sale of M16 rifles". The other two members were Congressmen Speedy O. Long and William Bray. The Ichord subcommittee hearings began on May 15 and lasted throughout the summer of 1967, ultimately amassing nearly 600 pages of fine-print testimony. Ironically, as Bill Davis remarks, "The purpose of the hearings was considerably subverted by efforts of those who had, in fact, been largely responsible for the problems that were under investigation".

Throughout the inquiry, the Army maintained with as much dignity as possible that there had indeed been a coherent plan behind the history of the M16's development. This was done without explicit mention of the OSD "direction" which had vetoed a multitude of technical recommendations from Springfield and Frankford Arsenal. Nor was it mentioned that, on many of these issues, the PMR had personally favored the advice of his technical advisors. Bill Davis, who after a year or so at Colt's was once more "a member of Col. Yount's staff", was present during much of the Ichord investigation. He remembers:

To his considerable credit, Col. Yount behaved with honor under the accusations that were levelled against him during the M16 investigations, even those which he obviously knew to be unjust. So indeed did..General Besson, conduct himself most honorably...At the sacrifice of his own professional reputation, Col. Yount did not plead the extenuating circumstances that had attended certain decisions for which he was being criticized, nor did he publicly disclose the obstacles that had so frequently been placed in his path by higher authority...His subsequent portrayal as an unmitigated knave or a fool, by those who pass judgement based on superficial evidence and the benefit of hindsight, does deeply offend my sense of justice. He was assigned a truly formidable task, to carry out under difficulties that would have been insurmountable for a man of less remarkable energy and resilience..

That the subcommittee did indeed suspect Col. Yount of being a "knave or a fool" is amply evident in the following scathing excerpt from the hearings:

Mr. Ichord [to Col. Yount]: ..We have evidence and are advised by our experts..that the ball propellant, which you apparently speak so highly of, does have an adverse effect upon the operation of the M16 rifle. It speeded up the cyclic rate. It is dirtier burning...When we are also advised that the Army was cautioned against making this change from IMR to ball propellant...Naturally, we would be quite concerned. Apparently you aren't so concerned. I don't understand your explanation. I just haven't been able to understand you - but perhaps you haven't offered the information in words that I can understand.

Would you care to say something?

Col. Yount did not reply. During the Ichord hearings he staunchly continued to tell as much of the truth as he could without casting the blame upwards, with sad results as, inexorably, the Army and he himself became ever more deeply and openly suspected of perfidy, not to say villainous chicanery. For example, Col. Yount did himself no favor at all by stating, truthfully, that the new buffer had been introduced "as a result of the SAWS study", wherein as we have seen the light strike problem had first shown up in full-auto HBAR firing trials. Another unfortunate but quite truthful remark, that the predominance of ball powder in the field had merely been "coincidental" to the sharp increase in malfunction rates which had followed the first general issue of old-buffered XM16E1s in Vietnam in the summer of 1966, was again misapprehended.

The *Real* Problem in Vietnam

Sadly, the key problems in the M16's "universe", as this study has attempted to reveal, required a rather high degree of specialized technical knowledge in order to be understood. The subcommittee's members, Congressmen all, were not ballistic experts, although sometimes one or another of them tried to be, with the overall result that the hearings were easily led astray from the key issues. As Col. Crossman had reported, 90% of the malfunctions in Vietnam were failures to extract the fired cartridge case. These sometimes remained tightly stuck in the chamber after firing, and had to be dislodged with a cleaning rod or actually pried out of the chamber. The subcommittee was therefore quite naturally interested in all aspects of the extraction problem, and questioned several witnesses on the issue. Gene Stoner himself testified that

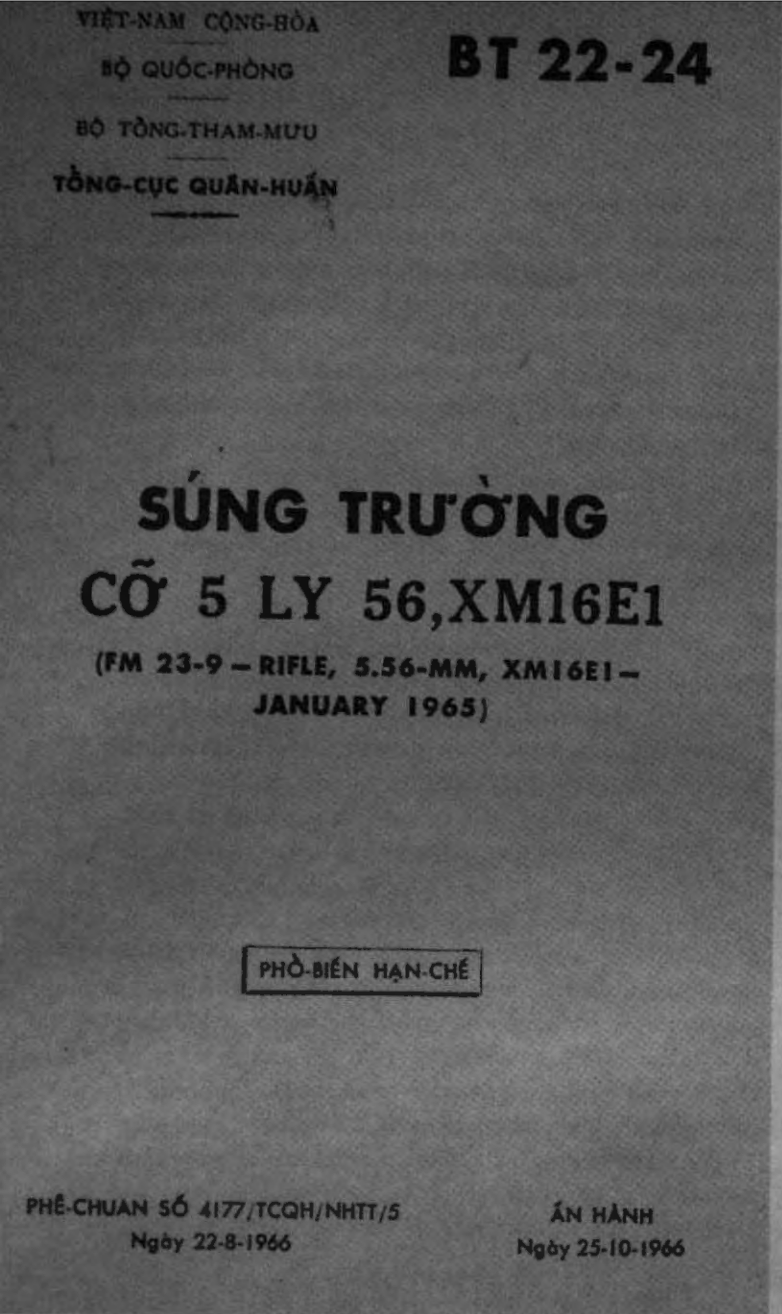
..the cyclic rate, if it is excessive, will tend to open a weapon too soon when there is considerable pressure in the chamber. This means -

Mr. Bray: What would that do, if you tried to open it with pressure too quick?

Mr. Stoner: Well, the cartridge tends to stick - under high residual pressure in the barrel, and of course with this too-soon action you also have a higher bolt velocity. In other words, your bolt is trying to open at higher speeds, so you have an aggravated condition where the cartridge is tending to stick in there a little longer or a little harder, and you are also giving it a harder jerk by driving the bolt faster.

Mr. Bray: Then a faster rate of fire could cause that situation?

Mr. Stoner: That is probably one of the worst conditions you can get, by increasing the cyclic rate.



VIỆT-NAM CỘNG-HÒA

BỘ QUỐC-PHÒNG

BỘ TỔNG-THAM-MƯU

TỔNG-CỤC QUÂN-HUẤN

BT 22-24

SÚNG TRƯỜNG

CỠ 5 LY 56,XM16E1

(FM 23-9 – RIFLE, 5.56-MM, XM16E1 – JANUARY 1965)

PHỔ-BIẾN HẠN-CHẾ

PHÊ-CHUẨN SỐ 4177/TCQH/NHTT/5
Ngày 22-8-1966

ẤN HÀNH
Ngày 25-10-1966

215. Featuring cheap paper and abysmally cloudy illustrations, the first Vietnamese-language edition of US FM 23-9 (January 1965) on the XM16E1 rifle was issued to ARVN forces under the date October 25, 1966.

The extraction failures Gene Stoner was describing were those attributable to the early opening of the bolt, wherein the basic cause is that residual chamber pressure is still too high, and the case walls are still expanded elastically and sticking to the walls of the chamber. However, this residual pressure is completely gone within a few milliseconds after firing, and cannot possibly hamper efforts to extract the case after that time. Failures to extract which are actually due to early opening of the bolt can easily be cleared by a subsequent manual cycling of the mechanism, barring a complete rim shear by the extractor. (Given cartridge cases of acceptable hardness, rim shears very seldom occur in the M16, due to its relatively weak extractor spring).

Failures to extract which required that the case be pounded out of the chamber by a cleaning rod, seconds or minutes after firing, were certainly not due to the early opening of the bolt.

However, Stoner's clear inference was accepted by the subcommittee and the extraction failures in Vietnam were also popularly ascribed to the higher cyclic rates produced by the Army's perfidious introduction of ball powder. This unfortunately succeeded in diverting suspicion away from a much more plausible cause of the malfunctions, which was lax case-hardness specifications compounded by chamber corrosion.

Chrome-plating of the bore and chamber in all new US military small arms had been a specifically stated requirement of the Ordnance Corps since about 1957 (discussed in *US Rifle M14*). This policy had been set forth in OTCMs (Minutes of the Ordnance Technical Committee) in consequence of experiences with rusty chambers and bores in the South Pacific during World War II. Unfortunately, however, at the outset of the M16 program the technology to produce chromed .22 caliber barrels simply did not exist. Early in the program Springfield Armory had recommended to the TCC that efforts begin forthwith to develop processes for chrome-plating the bores and chambers of M16 barrels. Reportedly acting on the advice of Gene Stoner, who claimed that the AR-15 bore and chamber needed no further improvement, OSD vetoed the Springfield recommendation. Had this proposal not succumbed to yet another Department of Defense "direction", the most serious problems experienced with the M16 rifles in Southeast Asia might well have been avoided, and it would not have been necessary to retrofit so many rifles a few years later with chrome-chambered (and still later fully-chromed) barrels.

The closest thing to an admission of any mishandling in the ball powder issue came in an official statement which the Army presented to the subcommittee on July 27 1967:

From the vantage point of retrospect, it has sometimes been suggested that the peculiar behavior of ball propellant in the M16 system should have been predicted. There was, in fact, no evidence in 1963 that the cyclic rate of the M16 would be greatly affected by the choice of propellant, provided that port pressures were controlled [which they were not] as they had been in the M14 and other 7.62 millimeter [gas cutoff and expansion] systems which accommodate both ball and extruded propellants. Furthermore, there was no evidence at that time to indicate that an increase of 10 percent to 15 percent in cyclic rate of fire would cause a serious increase in frequency of malfunctions.

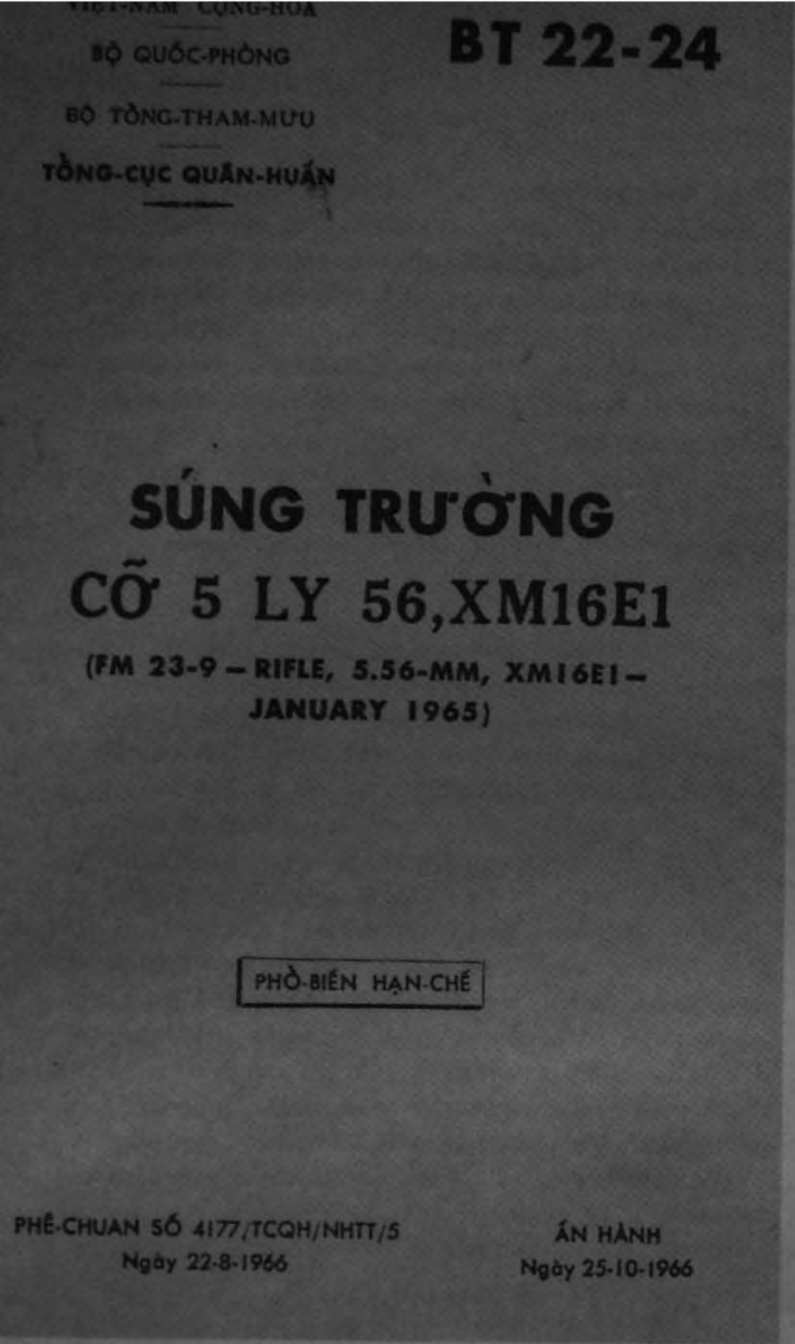
Had the Army anticipated these developments, it is most unlikely that the course chosen in January, 1964, would have been the same. A decision to reduce the velocity requirement, and continue loading IMR4475 propellant would probably have been made instead, and the development of alternate propellants could have been pursued more deliberately.

As we have seen, however, Frankford Arsenal's first report in its study of the AR-15 rifle/ammunition system was dated 4 April 1963, so the very limited amount of evidence allowed under Secretary McNamara's "keep it simple" policy *had* begun to accrue by then. Also, throughout that period Frankford *and* Gene Stoner had repeatedly called for traditional, ongoing compatability trials of the rifle-and-ammunition, especially after one or the other was modified. Under the constraints of the Gilpatrick directive and subsequent OSD "direction", however, the Project Manager had been forced to be pragmatic and, "in the absence of malfunction reports", ignore these and other warnings.

Regarding the effect of a cyclic rate increase of 10 to 15 precent on *parts breakage*, Gene Stoner told the subcommittee:

> *[the] cyclic rate, the higher it gets, of course, it is going to wear all the parts in a weapon, all the moving parts, because your impact loads go up, it is an energy function...the loads go up by the square of the velocity. If the velocity went up twice as fast, it isn't twice the load, it is at least four times as much. In other words, you don't put a little more load on them. You put twice as much [load] on them by running the cyclic rate up a couple hundred rounds a minute.*

In August, Mr. Ichord politely thanked the many witnesses who had appeared to testify before them, and the subcommittee then retired behind closed doors to prepare a final report. When this document appeared in October 1967, it concluded that grave mismanagement, errors of judgement and lack of responsibility had characterized the Army's handling of the entire M16 program.



VIỆT-NAM CỘNG-HÒA

BỘ QUỐC-PHÒNG

BỘ TỔNG-THAM-MƯU

TỔNG-CỤC QUÂN-HUẤN

BT 22-24

SÚNG TRƯỜNG

CỠ 5 LY 56,XM16E1

(FM 23-9 – RIFLE, 5.56-MM, XM16E1 – JANUARY 1965)

PHỔ-BIẾN HẠN-CHẾ

PHÊ-CHUẨN SỐ 4177/TCQH/NHTT/5 Ngày 22-8-1966

ẤN HÀNH Ngày 25-10-1966

215. Featuring cheap paper and abysmally cloudy illustrations, the first Vietnamese-language edition of US FM 23-9 (January 1965) on the XM16E1 rifle was issued to ARVN forces under the date October 25, 1966.

The extraction failures Gene Stoner was describing were those attributable to the early opening of the bolt, wherein the basic cause is that residual chamber pressure is still too high, and the case walls are still expanded elastically and sticking to the walls of the chamber. However, this residual pressure is completely gone within a few milliseconds after firing, and cannot possibly hamper efforts to extract the case after that time. Failures to extract which are actually due to early opening of the bolt can easily be cleared by a subsequent manual cycling of the mechanism, barring a complete rim shear by the extractor. (Given cartridge cases of acceptable hardness, rim shears very seldom occur in the M16, due to its relatively weak extractor spring).

Failures to extract which required that the case be pounded out of the chamber by a cleaning rod, seconds or minutes after firing, were certainly not due to the early opening of the bolt. However, Stoner's clear inference was accepted by the subcommittee and the extraction failures in Vietnam were also popularly ascribed to the higher cyclic rates produced by the Army's perfidious introduction of ball powder. This unfortunately succeeded in diverting suspicion away from a much more plausible cause of the malfunctions, which was lax case-hardness specifications compounded by chamber corrosion.

Chrome-plating of the bore and chamber in all new US military small arms had been a specifically stated requirement of the Ordnance Corps since about 1957 (discussed in *US Rifle M14*). This policy had been set forth in OTCMs (Minutes of the Ordnance Technical Committee) in consequence of experiences with rusty chambers and bores in the South Pacific during World War II. Unfortunately, however, at the outset of the M16 program the technology to produce chromed .22 caliber barrels simply did not exist. Early in the program Springfield Armory had recommended to the TCC that efforts begin forthwith to develop processes for chrome-plating the bores and chambers of M16 barrels. Reportedly acting on the advice of Gene Stoner, who claimed that the AR-15 bore and chamber needed no further improvement, OSD vetoed the Springfield recommendation. Had this proposal not succumbed to yet another Department of Defense "direction", the most serious problems experienced with the M16 rifles in Southeast Asia might well have been avoided, and it would not have been necessary to retrofit so many rifles a few years later with chrome-chambered (and still later fully-chromed) barrels.

The closest thing to an admission of any mishandling in the ball powder issue came in an official statement which the Army presented to the subcommittee on July 27 1967:

> *From the vantage point of retrospect, it has sometimes been suggested that the peculiar behavior of ball propellant in the M16 system should have been predicted. There was, in fact, no evidence in 1963 that the cyclic rate of the M16 would be greatly affected by the choice of propellant, provided that port pressures were controlled [which they were not] as they had been in the M14 and other 7.62 millimeter [gas cutoff and expansion] systems which accommodate both ball and extruded propellants. Furthermore, there was no evidence at that time to indicate that an increase of 10 percent to 15 percent in cyclic rate of fire would cause a serious increase in frequency of malfunctions.*
>
> *Had the Army anticipated these developments, it is most unlikely that the course chosen in January, 1964, would have been the same. A decision to reduce the velocity requirement, and continue loading IMR4475 propellant would probably have been made instead, and the development of alternate propellants could have been pursued more deliberately.*

Chapter Fourteen

SOME PARALLEL DEVELOPMENTS

The Unburied Ghost of One-in-Fourteen

In 1966, the still-contentious lethality/accuracy tradeoff inherent in the 1963 change from a 14" twist of rifling to 1 turn in 12" (chapter 8) sparked a new, year-long investigation:

Project: Rifles [week of] 24-28 October 1966

Twist of Rifle in XM16E1 barrel: *Colt's Inc. has been asked to estimate impact and time required for implementing the directive to revert to a 1 in 14 inch twist XM16E1 barrel. Mr. Goldbach, Vice President for Military Products, expressed very serious concern regarding the decision to revert ...Colt's previous experience with the 14 inch twist was unfavorable. On the basis of approximately 25,000 rifles, Colt's found that more than 10% of the barrels failed to meet the prescribed accuracy requirements in firing tests; even though the required dimensions and tolerances were met in manufacture. They anticipate significant impact on detail of rifles if 1:14 inch twist is again to be required, unless accuracy requirements for acceptance testing were considerably relaxed at the same time..*

To General Besson, who was growing increasingly concerned about the problem-plagued M16 program, this announcement had appeared "inconsistent..What does BRL say?"

On November 17 the PMO replied with a special memorandum, which General Besson proceeded to scribble all over:

Twist of Rifle in XM16E1 Barrel

..BRL..tends to..support..Colt's contention that a significant impact on the rifle program could be expected if the 1:14 inch twist is required unless considerable relaxation of the accuracy requirements..is authorized.

*The BRL report [*Recommended Twist Rate for AR-15 Rifle, *6 September 1963] points out that:*

- Round-to-round dispersion, as a function of temperature and twist rate, is greater for the 1:14...[and] even greater at colder temperatures.

- The 1:12 twist yields equivalent or higher hit probabilities than the 1:14..for all ranges, temperatures and aiming errors. [Here the first of General Besson's comments reads: "But less kills per hit and maybe less kills per shot. The 1:12 doesn't tumble as easily as 1:14"]

What..BRL does not consider (and this is the point Colt's is trying to make) is the greater difficulty they encountered when mass producing 1:14 twist barrels. [General Besson's "Why?" went unanswered.] These barrels, when tested against 1:12 twist, did not prove to be superior as far as accuracy is concerned. [G.B.: "Never will be..You have to relax cold weather accuracies if you go to 1:14 - and all other accuracies as well."]

At the time of its adoption in 1963, the AR-15 (XM16E1) was scheduled for use by Strategic and Special Forces, in particular, who might be required to fight anywhere in the world, without regard for climate. If [the XM16E1] is made STD-A, as recently directed by the Chief of Staff, Army, the worldwide performance criteria become all the more important.

After a few pointed reminders from General Besson, Col. Yount had reported just a few days after the official type classification of the M16A1 on February 28 1967, that the TCC had reaffirmed the 1:12 twist, but had called for some additional lethality testing. Accordingly, 1,000 barrels were ordered from Colt's with a 1:14 twist, for use in a comparison trial with 1,000 brand new M16A1s fitted with 1:12 barrels. This was supposed to take place in July 1967, but Colt's was on strike for some time during that period, which also saw Col. Yount relieved of his duties as Project Manager.

Weekly significant action reports on the rifle project subsequently appeared over the signature of Lt. Col. Robert C. Engle, formerly the Washington-based PMSO, who had been appointed Acting PMR the previous month:

Project: Rifles [week of] 4-8 September 1967

Barrel twist: *A report dated 25 August 1967, entitled "Parameters Affecting Bullet Stability"..summarized progress to date on various engineering investigations..which will provide the data necessary for a final decision on the barrel twist ...One aspect..involves..the amount of increase in lethality which could be expected by reducing the stability of the bullet. [Here General Besson intervenes again: "Won't this also affect accuracy - seems to me we are chasing our tail.."].*

Bill Davis remembers the interesting events surrounding the actual trial of the special 2,000 rifles:

..years after the Air Force representatives in the TCC had prevailed in their insistence upon the 12" twist, and the change had been incorporated in all production, the OSD protagonists resurrected the question and gained sufficient support to demand another full-scale test involving production rifles.

Production of rifle barrels at Colt's was temporarily suspended to retool the barrel line and produce 1,000 barrels having 14" twist, by exactly the same production methods being used for the standard barrels having 12" twist. One thousand new rifles were equipped with these barrels. There were 500 rifles having 12" twist set aside from production immediately preceding the test rifles, and 500 more from production immediately following the test rifles, after the barrel line had been retooled again for the 12" twist. Three different lots of M193 ammunition were selected for the tests, of which one lot represented the most accurate lot available in current inventory, one represented the least accurate..and one represented as nearly as possible the typical accuracy of production M193 ammunition..

[Engineers James Ackley and Charles Fagg] from the Project Manager's staff [were] sent to witness the testing at Colt's. There were three ten-shot groups fired for accuracy with each of the 1,000 test rifles, and three groups with each of the 1,000 control rifles, under identical conditions of testing. The barrels were then sent to Aberdeen..for confirmation that their critical dimensions were as specified. Two barrels, as I recall, were incorrectly marked as having 14" twist, and were found in fact to have 12" twist instead, having apparently been mismarked inadvertently at Colt's. Otherwise, everything was found to be in accordance with the test plan.

The average extreme spread for the 998 rifles having 12" twist was 3.6 inches at 100 meters, while that of the 1,002 rifles having 14" twist was 7.2 inches, or exactly 100% greater.

The Watershed SAWS Results - the SPIW is "Reoriented"

The two-year, worldwide SAWS program and its many convoluted offshoots, it will be remembered, had been running since December 1964, providing along with much other data the first ominous reports of chronic XM16E1 malfunctions. During its portion of the SAWS test, the US Army Test and Evaluation Command (TECOM) had recorded an unacceptably high overall malfunction rate of 10.6/1,000 rounds. As if foretelling Col. Crossman's damning report to the Ichord subcommittee, TECOM had concluded:

The relative low level of functional reliability of the XM16E1 rifle in these tests is not considered representative of the normal performance which can be expected from this weapon, which has been demonstrated in past tests, but is considered to indicate a need for improvement in quality control in weapon manufacture and for investigation of the effects of ammunition upon weapon functioning.

216. The AAI "SPIW Weapons Family" circa early 1966. From left: prototype belt fed LMG (note early square-section muzzle brake); prototype "bullpup" SPIW Carbine; second-generation SPIW rifle, caliber 5.6mm XM645, fitted with a single-shot DBCATA grenade launcher (chapter 15); second-generation SPIW rifle (point-fire only), on bipod.
Courtesy AAI Corporation

As another example of the variety of tests performed during SAWS, the following excerpts are from the final report of CDCEC's mentioned IRUS Field Experiment, wherein had occurred the first of the still-baffling ruptured cartridge cases:

..Field experimentation was conducted to determine the relative effectiveness of rifle and machinegun squads armed with US 7.62mm, Soviet 7.62mm, Colt 5.56mm and Stoner 5.56mm weapons..

Squads armed with low impulse 5.56mm weapons were superior to squads armed with 7.62mm weapons in target effects, sustainability of effects, and overall effectiveness. Duplex ball ammunition was generally superior to Simplex ball ammunition at close ranges..

Rifle squads armed with Colt weapons and..squads armed with Stoner weapons are approximately equal in effect. [However] because of the lighter system weight and related advantages in sustainability, rifle squads armed with Colt weapons are superior..

Rifle squads equipped only with Colt automatic rifles appear superior to all other squads evaluated in overall effectiveness..

Hypotheses that high muzzle impulse weapons are superior to low muzzle impulse weapons at longer ranges (300 to 550 meters) are not supported.

Hypotheses that lightweight rifles with high sights and straight stocks, such as the M16A1, are inferior or inadequate in pointing fire are not supported.

A squad equipped only with M14 rifles is superior to a squad equipped with any other single US 7.62mm weapon, or combination of these weapons.

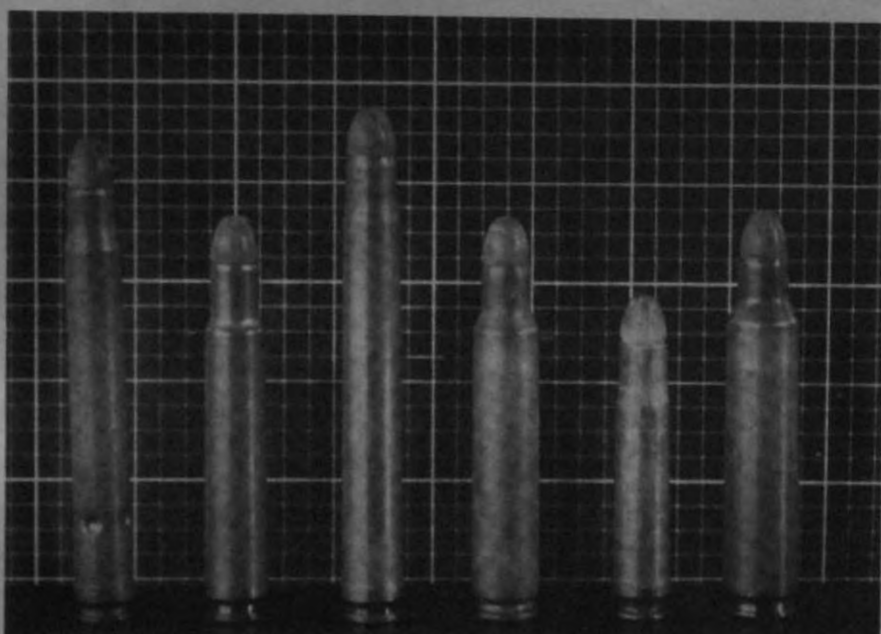
In yet another ironic twist, the Army's XM16E1 problems in Vietnam had coincidentally erupted at the very same time as the long-awaited results of SAWS were first released. Although the final, thirty-volume report was not "official" until December, by August of 1966 Col. Yount was already briefing some AMC general officers and others on the status of the SAWS activities, which foretold the impending and severely embarrassing collapse of the SPIW program and, in consequence, a much heavier reliance on the 5.56mm M16/XM16E1 rifle system.

By October 1966 the Army's then Chief of Staff General Johnson, who had only months earlier been seriously weighing the pros and cons of issuing American troops in Vietnam with mothballed M1s rather than buying more XM16E1s, informally advised Secretary McNamara that it was the Army's intention to replace "the caliber .30 weapons in the inventory as soon as possible and to replace the M14 and M14A1 rifles, the objective being a single-family weapons inventory of the Colt [XM16E1] individual weapons and, for the present, the M60 machinegun".

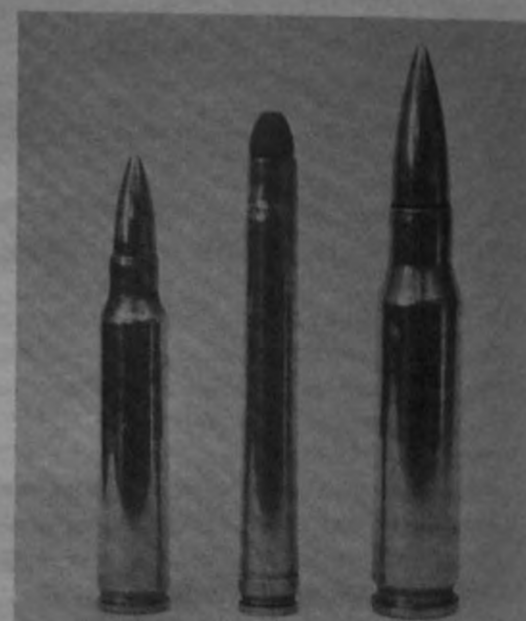
By December 17, 1966 it was official. Secretary of the Army Resor informed McNamara that "the XM16E1 rifle is generally superior for Army use [and] the current SPIW program is unlikely to result in a satisfactory weapon as early as previously forecast. Based on experimental findings, it is likely that some minor changes in the M16 system are justified. These include

217. A wood-stocked prototype of the short-lived, second-generation Springfield Armory SPIW, caliber 5.6mm XM216 (fig. 218 no. 4) fitted with a later version of the Winchester "blow-forward" grenade launcher (fig. 152). One of Springfield's last development projects, due to Secretary McNamara's Armory closure order.

Springfield Armory photo dated December 21, 1965



218. A compendium of (actual size) single-flechette SPIW cartridges. From left: 1. AAI first-generation 5.6x53mm XM110, unheadstamped; 2. Frankford/Springfield first-generation 5.6x44mm XM144, headstamped WCC 63; 3. AAI second-generation 5.6x57mm XM645, case made in Canada under Ordnance contract and headstamped IVI 71; 4. Frankford/Springfield second-generation 5.6x44mm XM216, unheadstamped; 5. experimental AAI SPIW pistol flechette cartridge, made from a cut down XM110 case and headstamped WCC 64; 6. standard AAI flechette-and-sabot loaded in a 5.56x45mm M193 case, headstamped REM-UMC 223. *Editor's collection*



219. A size comparison. From left: the 5.56x45mm M193 ball; the 5.6x57mm XM645 saboted single flechette; and the 7.62x51mm NATO M80 ball.

use of a different powder grain in the cartridge and a change in the barrel twist...The Stoner family of 5.56mm weapons has some attractive features, but no effectiveness advantages that might warrant adoption by the Army at this time".

As further discussed in *The SPIW,* the SPIW program was at this point face-savingly "reoriented" back to a status of "exploratory development".

As noted, the SAWS field experiments had provided the Army with an ironclad two-year excuse for temporizing on the issue of a main battle rifle. The watershed SAWS conclusions were accordingly hailed as the main rationale for the subsequent about-face regarding the M16. As Dr. Carten later put it, "SAWS..was the decisive factor leading to the Army adoption on 23 February 1967 of the XM16E1 as the M16A1." As also noted, Colt's new production contract ("0018") had already been officially "definitized" in June 1966.

As discussed in chapter 17, the SAWS decision also led to a rekindled interest in an old, old bone of contention that had dogged the Army's dealings with the Colt company since the first military involvement with the AR-15 back in 1963; namely, the manufacturing rights to Colt's proprietary M16/M16A1 rifle.

Ten Post-Production Changes to the M16/XM16E1

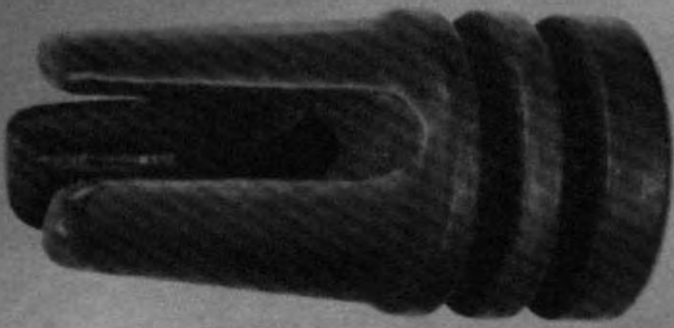
220. M16A1: a late lower receiver group, partially stripped. Note the post-production changes from top left: the lightened firing pin, parkerized bolt-and-carrier and new firing pin retaining pin (compare with fig. 137); and new buffer.

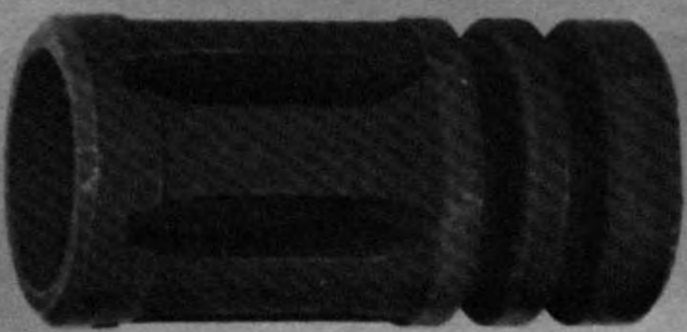
Eleven basic improvements had been built into the one-time buy (contract "508") *before* production had begun on the M16/XM16E1 rifle (chapter 8). All additional purchases of rifles and proprietary accessories up to December 1965 had been officially classed as "add-ons" to that initial contract. Indeed, even after General Westmoreland's successful call for 100,000 new XM16E1s, "definitization" of contract "0018" took a further six months (due mainly to the complications of the rights issue).

During this period, a number of further modifications were made to the rifle. In fact, the Korea-bound Col. Yount informed the Ichord subcommittee in July 1967 that during the hectic life of contract "508", 129 Requests for Technical Action (RTAs) had been received, of which 123 had been approved. By June 30, 1967, the total number of RTAs had risen to 159 on both contracts. In further testimony, Col. Yount identified the following ten major engineering changes to the M16/XM16E1 as "modifications which significantly improved the weapon":

1. gas tube material changed to stainless steel, to eliminate corrosion and rusting in the original tube. (When asked to admit that the old tube was more apt to corrode, Col. Yount stoutly held that it was merely "less corrosion resistant").

2. bolt hardness specification revised, to provide improved bolt life. An improvement, no doubt; but as Bill Davis first pointed out in Colt's Ammunition Variables report (chapter 12), necessary only after the higher cyclic rates began to increase stress and accelerate wear on this critical component.





221. Second and third type flash suppressors.
Above: type 2.
Below: the improved "birdcage" model (post-production change no. 9), introduced in January 1967.

3. bolt carrier key finish altered from electrolyzed to chrome-plated interior/parkerized exterior.

4. firing pin retaining pin - changed from a machining to "a less expensive and more durable" cotter pin.

5. bolt catch redesigned; a "field fix" for bolt catch problems engendered by the higher cyclic rates brought about by ball powder. The catch body was made wider in order to reduce the effects of, in Col. Yount's words, its "slamming into the lower receiver". (Colt's later reported that in April 1966 they had also increased the load on the bolt catch spring, in order to overcome bolt catch-related malfunctions which "had not been noticed as a problem prior to the introduction of ball propellant").

6. disconnector redesigned, again to better accommodate the added shock resulting from higher cyclic rates.

7. a protective boss added to the lower receiver, around the magazine catch. This was in response to complaints of the catch sometimes being pressed in by heavy brush, and the magazine dropping out.

8. the new buffer, introduced in December 1966 as a replacement for the temperamental "action spring guide assembly", designed to dampen bolt carrier bounce and prevent misfires due to light stikes. At the same time, it slowed down the high ball-powder cyclic rates.

9. a new flash suppressor, the third basic type since the days of the Colt model 01, approved in September 1966. Known as the "birdcage" model, its ringed muzzle end did away with the problem of catching the old design's prongs in vines, tall grasses and brush. In addition, the "birdcage" suppressor channeled less rainwater into the bore than had the open-ended prongs. This item was built into all new production beginning in January, 1967.

10.Significantly, another modification to the bolt, wherein it was shot-peened to increase its fatigue life and thereby its service life.

Unfortunately, the chrome-plated chamber had not even been approved until 26 May 1967, and thus did not figure in the list of changes to contract "508" or indeed its successor,"0018".

A Last Modification to the Air Force M16

On 9 August 1967 the Air Force reported that they had 136,506 M16 rifles on inventory, and that all their units fighting in Vietnam were now M16-equipped. One of the last modifications to the M16 had been Air Force acceptance of the serrated M16A1 bolt carrier, which although useless *per se* in the M16 did have the decided advantage of eliminating plain, un-serrated carriers as an item of manufacture and issue. Thus was solved the problem of plain carriers inadvertently turning up in M16A1s.

222. The barrel, swivels and front sight block of this dummy training rifle (clearly marked "M16A1 serial 604005") are the only metal parts: the rest is molded, one-piece plastic. Bob Miller collection, photo by Roy Arnold

The Rifle According to Colt

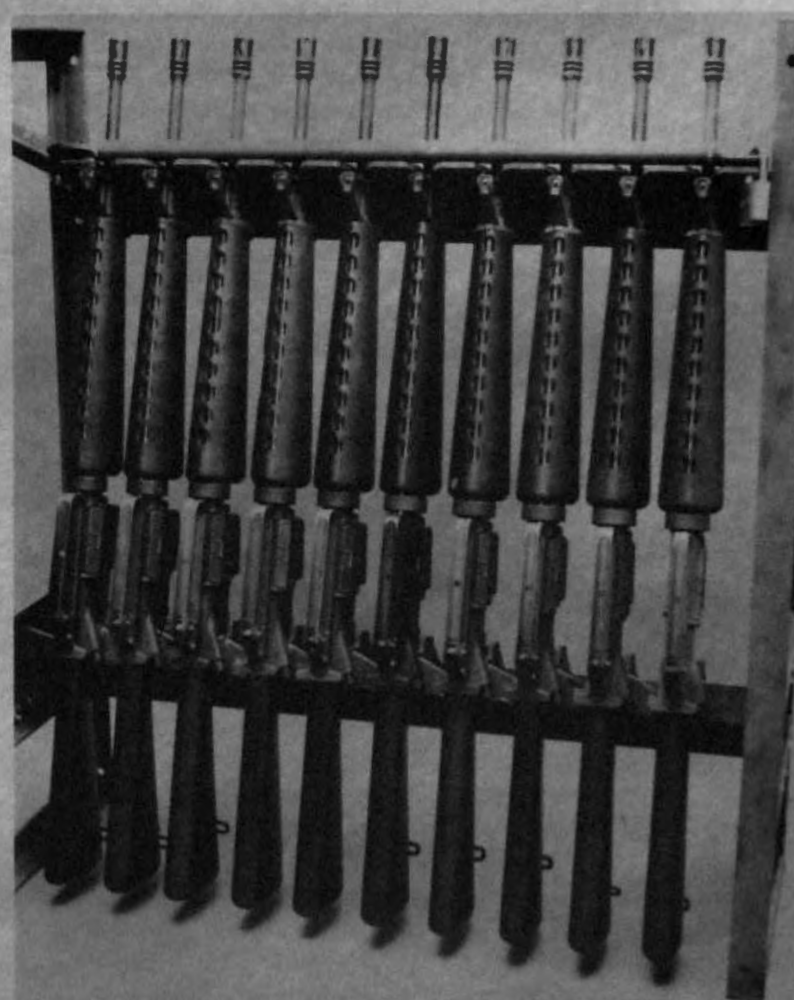
In his testimony before the Ichord subcommittee, the then-president of Colt's Paul Benke was asked to discuss the "126 parts" that made up the XM16E1 rifle, from the standpoint of who made what. Mr. Benke told the Congressmen that Colt's themselves only made the ten most important of the 126 parts in-house, the rest being obtained from subcontractors and variously only heat-treated, finished, or coated at Colt's before being inspected and assembled. Of the ten major Colt-made parts, Mr. Benke went on:

> *..We manufacture all of these parts from raw materials, and perform all the operations on them from either barstock, forging or castings as the case may be..*

Colt's vice-president of manufacturing, William Goldbach, continued:

> *Actually the 10 parts that we do manufacture..include possibly 65 percent of the total labor input in..hours into the rifle, so 10 parts don't appear to be a great number..but the other 116..are minor...The major parts are produced by Colt.*

The following list was inserted into the record of the Ichord transcript as "exhibit C of the technical data sales and patent license agreement, dated June 30, 1967". Interestingly, the list also includes the Colt-made components of the Army and Air Force submachine gun versions (discussed in chapter 15) and illustrates the exponential proliferation of components that resulted when just these two basic models were compounded by the Army-only bolt closure device:



223. A rack of ten brand-new M16A1s at Colt's, awaiting shipment to Vietnam. Colt photo by Ed Guinan

[Components Manufactured by Colt's Firearms Division]

M16, M16A1, XM177, and XM177E2

Part name	*Present part number*
Bolt	*61538*
Bolt carrier (M16 and XM177)	*61544*
Bolt carrier (M16A1 and XM177E2)	*62274*
Bolt carrier key	*61547*
Extractor	*61562*
Receiver extension (M16 and M16A1)	*61574*
Receiver extension (XM177 and XM177E2)	*62356*
Barrel extension	*61575*
Front sight (M16 and M16A1)	*62068*
Front sight (XM177 and XM177E2)	*62375*
Barrel (M16 and M16A1)	*62181*
Barrel (XM177 and XM177E2)	*62363*
Barrel and barrel extension assembly (M16 and M16A1)	*62180*
Barrel and barrel extension assembly (XM177 and XM177E2)	*62362*
Upper receiver (M16 and XM177)	*62306*
Upper receiver (M16A1)	*62278*
Upper receiver (XM177E2)	*XM7306*
Charging handle	*62288*

Chapter Fifteen

THE GOLDEN AGE OF R&D

The Cream of Colt's CAR-15 System - The Shorty Program

224. Further evolution of the CAR-15 submachine gun.
Above: the first-issue model; an XM16E1 with a 10" barrel and Colt's first type of noise suppressor, and the extendable buttstock. These early suppressors had a tight exit hole (for maximum effect) which, in conjunction with higher muzzle velocities (from the 10" barrels) led to heavy barrel coppering and tracer bullet failures (fig. 272).

Below: the final model, marked "XM177E2" (Colt model 629). Longer (second type) Colt noise and flash suppressor (fig. 230) on 11 1/2" barrel, round handguards, canted slip ring, and plastic-coated, telescoping buttstock.
Rock Island Arsenal collection, photo by Richard S. Smith

As discussed in chapter 11, by the time production had begun on the FY64 "one-time buy" of M16/XM16E1s, Colt's had optimistically worked up a seven-version "CAR-15 [Colt Automatic Rifle] Infantry Weapons System" of six different versions plus a rifle/grenade launcher combination, all based on the AR-15/M16 rifle. Most of these never made it beyond the handbuilt prototype stage, but, as noted, 100 to 150 of Colt's clip-fed, heavy-barrel "M1" Assault Rifle had been featured in the SAWS program. By early 1966, the Army was also showing considerable interest in the 10" barreled submachine gun.

First official notice of the CAR-15 submachine gun appeared in the following PMR's significant action report:

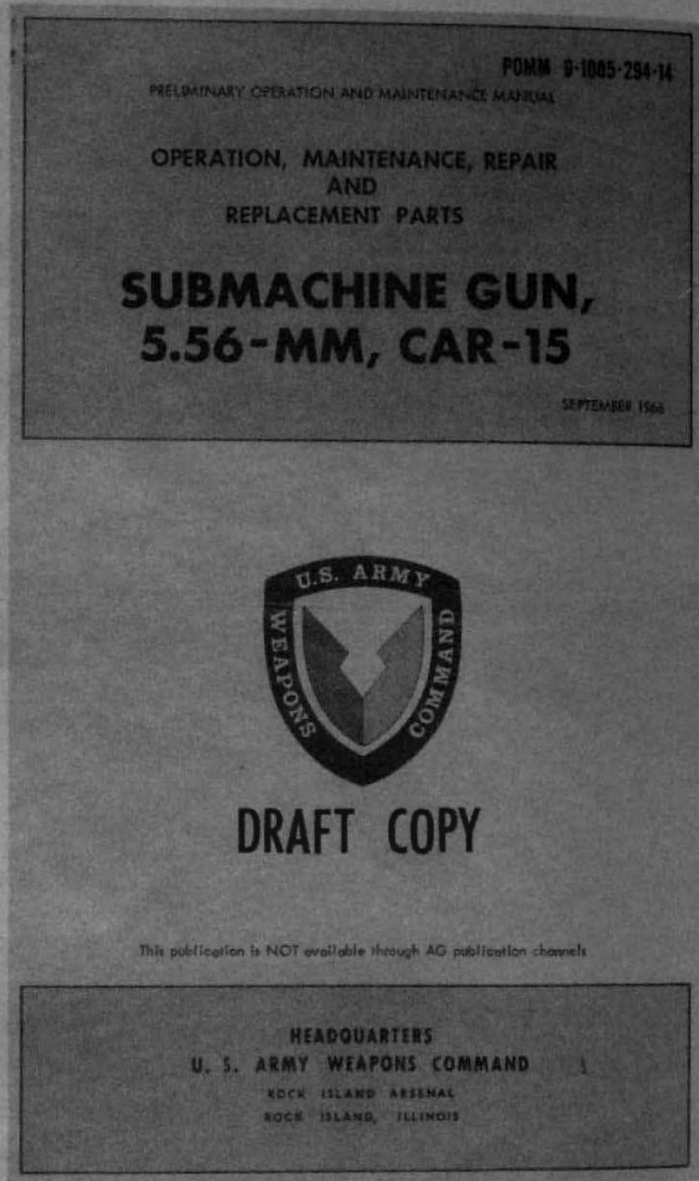
> Colt submachine guns: *Program authority was received this week for procurement of 2,050 Colt submachine guns. It is intended to procure these items on a letter contract with anticipated award by 15 March 1966. Initial deliveries are scheduled for September 1966 with completion scheduled in November 1966.*

Later in February 1966, then-Lt. Col. Yount announced that the US Army Assistant Chief of Staff for Force Development (ACSFOR) had increased the requirement by 765 more Colt "Commandos", the first official use of this nomenclature. The contract with Colt's for 2,815 CAR-15 "Commando model" submachine guns was accordingly signed on 28 June 1966.

After successfully completing a standard Engineering Design Test at Aberdeen, wherein Colt's regular pronged flash suppressor was evaluated on the short barrel for "noise level, flash, durability, reliability and accuracy", initial shipments of what had by then become known simply as the "CAR-15" were still on track for September. However, a problem developed, due to the blast and fireball which accompanied every shot out of the 10" barrel:

Project: rifles [week of] 22-26 August 1966

CAR-15 submachine gun: *[TECOM] safety certification is being withheld pending a retest of noise level measurements. Retesting is due to inconsistencies revealed during examination of initial test data..*



POMM 9-1005-294-14

PRELIMINARY OPERATION AND MAINTENANCE MANUAL

OPERATION, MAINTENANCE, REPAIR
AND
REPLACEMENT PARTS

SUBMACHINE GUN,
5.56-MM, CAR-15

SEPTEMBER 1966

U.S. ARMY WEAPONS COMMAND

DRAFT COPY

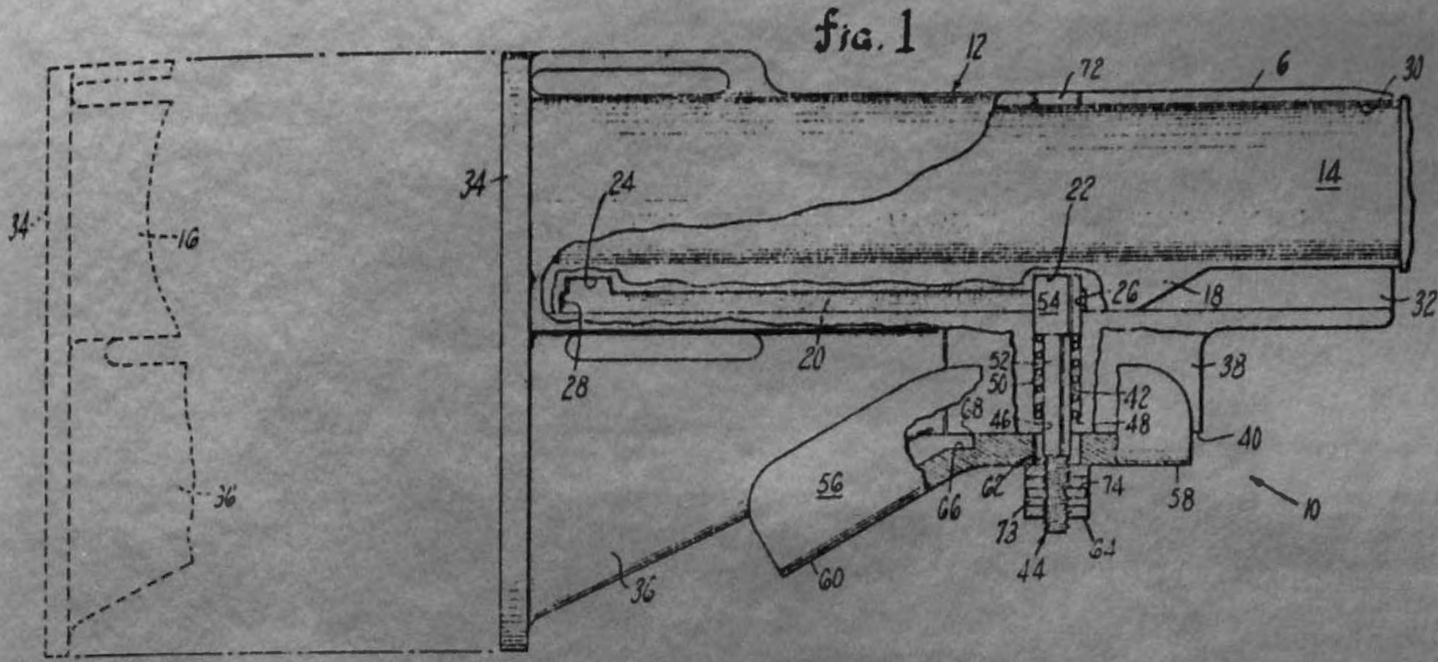
This publication is NOT available through AG publication channels

HEADQUARTERS
U. S. ARMY WEAPONS COMMAND
ROCK ISLAND ARSENAL
ROCK ISLAND, ILLINOIS

225. The cover of the early Rock Island Arsenal POMM for the "Submachine Gun, 5.56mm, CAR-15", dated September, 1966. The manual lists the muzzle velocity from the CAR-15's 10" barrel as 2,650 fps.

226. The second official name for the "CAR-15": the "Commando" (Colt model 609), with the longer noise and flash suppressor (fig. 230) mounted on a 10" barrel. This weapon has an (added) Colt burst control kit and a (later) 30-round magazine. Note the "PROPERTY OF U. S. GOVT" markings.

Bob Miller collection, photo by Roy Arnold



227. Fig. 1 from US Patent no. 3,348,328, entitled "Adjustable Buttstock", Rob Roy's second such (fig. 184). Much simpler in concept and execution, the stock telescopes around the recoil spring tube and its added lower rail, shortening the overall length with stock extended (31.25") to 28". US Patent Office

The CAR-15 Commando Becomes the XM177/XM177E1

A test of "one tool-room model" of Colt's "latest configuration" CAR-15 in September featured for the first time a special Colt "noise and flash suppressor", developed in an attempt to reduce the signature of the CAR-15 to the level of the standard rifle. Deliveries began on 7 November, with the shipment of "1190 sub-machine guns and 85% total repair parts". The next mention in the Project Manager's report for the week of 23-27 January 1967 established official type designation of the CAR-15 Commando for the first time:

> CAR-15 submachine gun*: The Type Designator SUBMACHINE GUN, 5.56mm. XM177 (Air Force Version) and XM177E1 (Army Version) has tentatively been assigned to the CAR-15 SMG.*

The XM177E2 - One of the Deadliest Fruits of the War

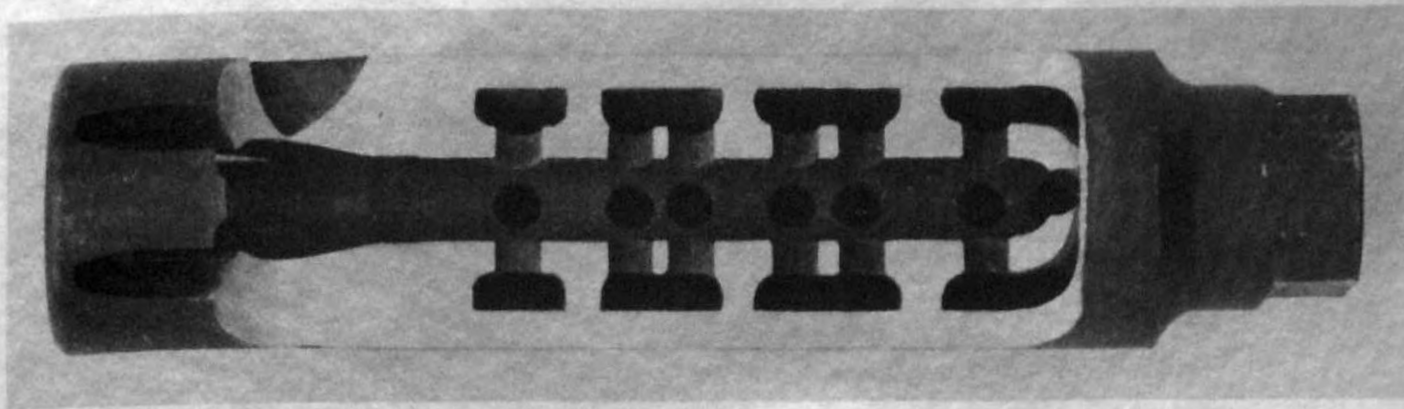
Improvements to the XM177/XM177E1 included an additional 1.5 inches of barrel length which, when mated with a redesigned Colt noise and flash suppressor, offered the best possible trade-off between versatility and increased noise and flash. Col. Yount reported:

Project: rifles [week of] 17-21 April 1967

> XM177/XM177E1 submachine gun*: Consistent with improvements made..a new designator, XM177E2, has been assigned to the current model.*
>
> *Contractual actions are in process to procure 510 each XM177E2 submachine guns with concurrent repair parts for the Studies and Observation Group, Vietnam [MAC-SOG]. Delivery date is anticipated by 30 September..*

228. Left side view of two rare toolroom "shorties" from Colt's.
Above: Colt model 610B (Burst) fitted with the late type noise and flash suppressor on a standard 10" barrel. Note the unusual ribbed handguard slip ring. The early telescoping buttstock is not plastic coated.
Below: non-U. S. Property-marked Colt "Commando" with experimental finned 10" barrel. *Bob Miller collection, photo by Roy Arnold*

229. Right side view of two more experimentals from the Colt model shop.
Above: an M16A1 fitted with an unusual 11" heavy barrel.
Below: final 11 1/2" barrel configuration as used on the XM177E2.
Bob Miller collection, photo by Roy Arnold



230. Cutaway view of Colt's longer, second-type noise and flash suppressor, which featured a larger exit hole and an added flash suppressor. When new, this device reduced the muzzle blast and report from the XM177E2's short barrel to roughly that of a standard rifle. Accumulated bullet particles and other debris would clog the suppressor, raising noise levels.

Bob Miller collection, photo by Roy Arnold

231. Closeup of the later USAF version of the telescoping-stock "shortie": the bolt-closerless XM177 (Colt model 649). Barrel length: 14" overall, including suppressor. Note the Air Force marking "GAU", standing for "Gun, Automatic".

Smithsonian Institution collection

232. Right side view of two typical Army XM177E2s, with stock extended (above) and telescoped (below). Note the Ordnance acceptance mark, stamped in paint on the receiver, and the late-style M16A1 protective boss around the magazine catch, modification no. 7 of the Ten Post-Production Changes (chapter 14).

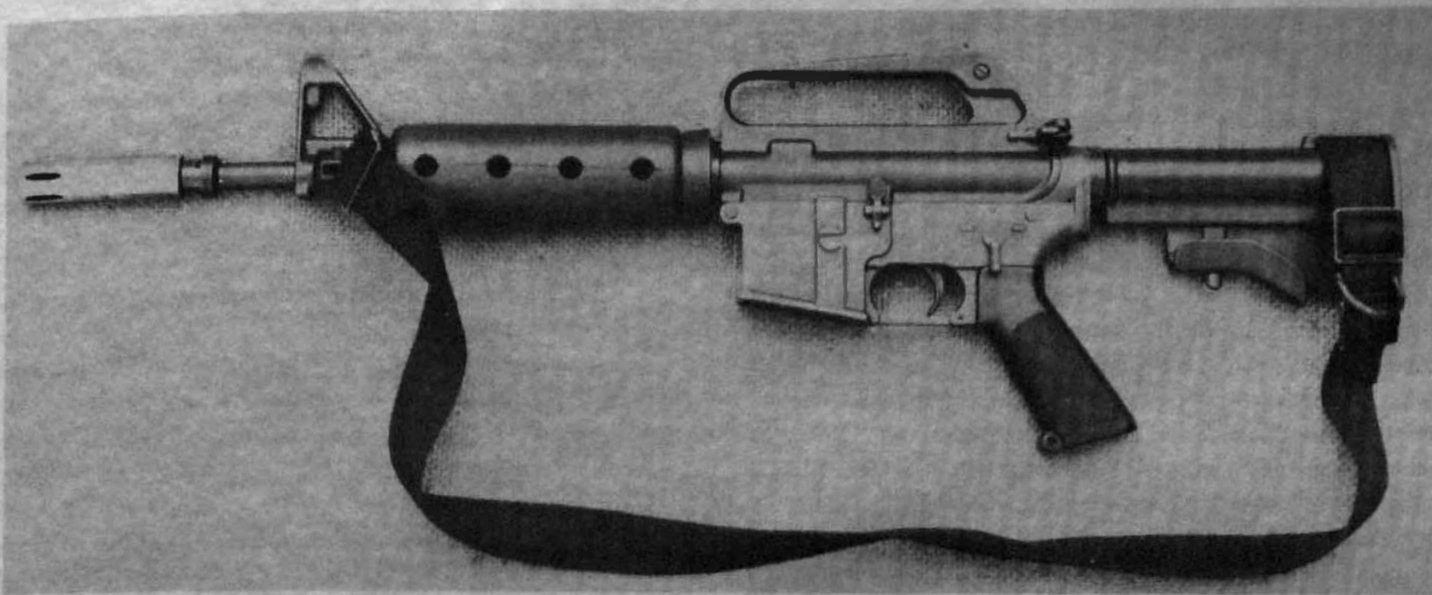
However, problems dogged the XM177E2:

Project: rifles [week of] 8-12 July 1968

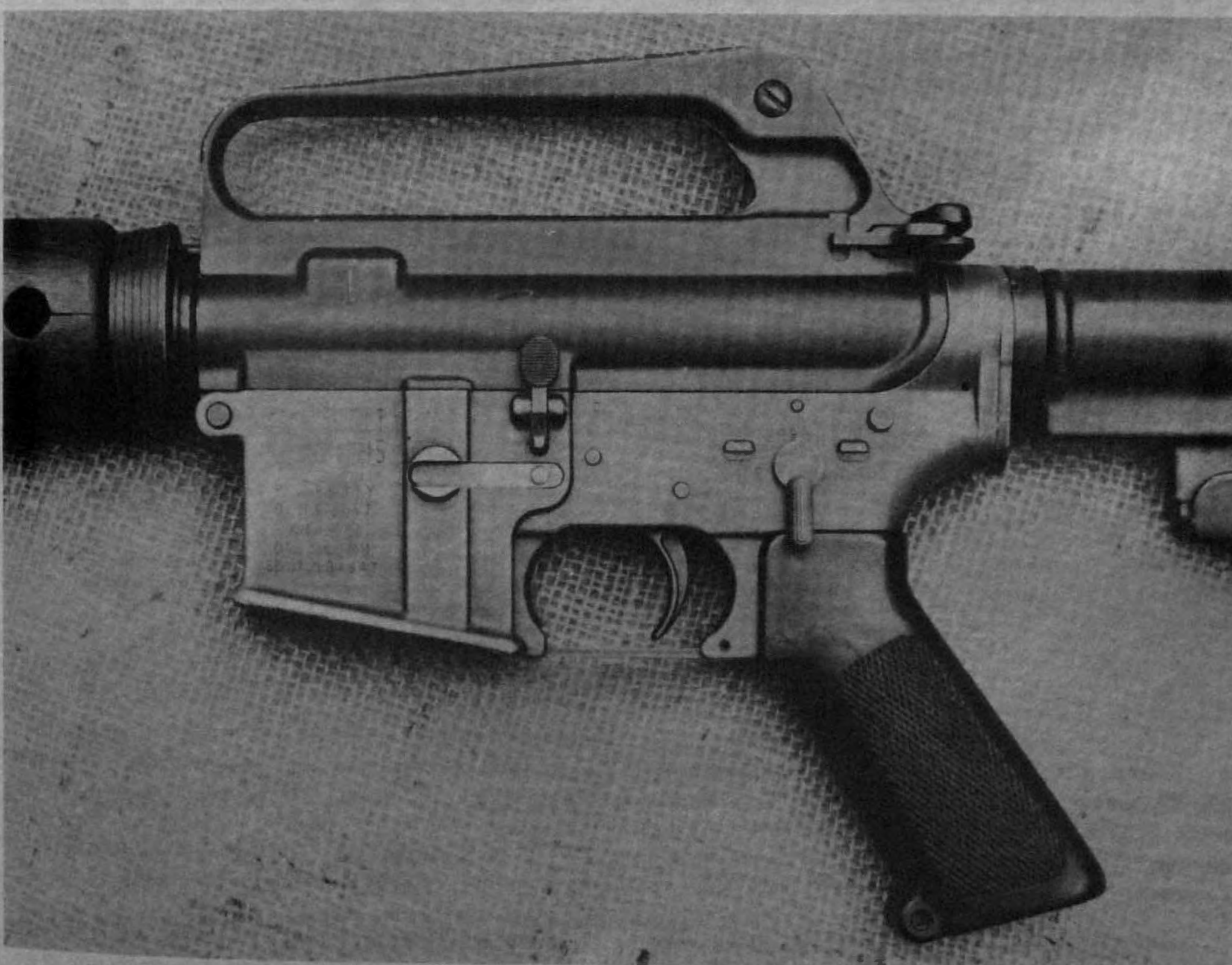
Submachine gun 5.56mm, XM177E2: *..The cyclic rates of the test weapons showed large variations within a burst. The noise/flash suppressor lost its effectiveness due to clogging as firing progressed, and the ball bullets showed unusually large yaw on some occasions apparently owing to the effect of the..suppressor. Tracer cartridges, regardless of the propellant loading were incompatible with the weapon due to severe yaw and some projectile breakup.*

USATECOM recommended further development of the buffer and noise/flash suppressor and that the [experimental] Delrin charging handle latch be considered unacceptable. The handles showed structural failure at -65°F.

(The Delrin charging handle latch mentioned above had been experimentally developed after Colt's started noticing yet another problem, that of the charging handle unlatching [malfunction code CHU] during the 1966 Frankford Arsenal ball/IMR ammunition trials. Colt's had again recorded that "Prior to the introduction of ball propellant, CHUs had not been noted as a problem". The high CHU malfunction rate led to Colt's making some changes to the regular metal charging handle latch [RTA-0018-4, 11 May 1966] and the charging handle latch spring [RTA-0018-5, 25 May 1966]. The Delrin latch idea was not adopted.)



233. Left side view of an XM177E2, modified by members of the Royal Australian Regiment (wood handguard) for use in Vietnam.
Photo courtesy Ian Skennerton



234. Closeup of receiver of the Royal Australian Regiment's wood-handguard "shortie", marked "PROPERTY OF U. S. GOVT. / XM16E1".

The XM177E2 is Phased Out

It was announced in the weekly PMR report for 11-15 November 1968 that Colt's had estimated a complete ballistic/kinematic study of the XM177E2 would take six months and cost $400,000. While extremely popular with the SEALs, Special Forces, LRRPs and other units to whom the XM177E2 had been issued, the 11.5'' barrel's necessary limitations in range and accuracy finally caught up with the shorty program. The last mention in the PMR's reports came in late December, 1968, when an in-process review of ''design characteristics'' recommended that the XM177E2 be reoriented to a 29-month, $635,000 R&D program. This recommendation was ignored and, concurrent with the winding down of the US presence in Vietnam after 1970, the ''Commandos'' went out of production.

In the mid-seventies the Treasury Department's regulatory Bureau of Alcohol, Tobacco and Firearms (BATF) decided that the XM177E2's noise and flash suppressor (fig. 230) was a true silencer under the law. This, coupled with a Carter-administration decision prohibiting export sales of silencers was the last straw, as it meant that Colt's could not sell the XM177E2 abroad.

After the war, as part of the recommencement of production of civilian semi-auto AR-15s, the XM177E2 was transmogrified into several special, suppressor-less full-auto ''CAR-15'' models with 11 1/2, 14 1/2 and 16'' barrels for law enforcement sale only, as well as a legal 16''-barreled semi-auto model featuring the XM177E2's telescoping buttstock called the ''Colt Sporter Carbine'', for civilian sale.

Militarily, after successful trials during the early eighties, Army and Marine Corps acceptance of Colt's new ''shorty'' version, called the XM4, appears imminent at the time of this writing (February 1987).

The Thirty-Round Magazine

235. Right side view of a Colt model 616, the CAR-15 ''Heavy Assault Rifle M1'' circa July 1966, with regular M2 rifle bipod mounted on adapter (fig. 173). Note the early 30-round, fully curved *magazine (fig. 406 type 4).*

Concurrent with the ''shorty'' program, the Combat Developments Command (CDC) first established a requirement for a 30-round magazine for the M16/M16A1 in January 1966. All subsequent production at Colt's on contract ''0018'' was supposed to be so equipped, especially the newly-ordered ''Commando'' submachine guns.

Gene Stoner had explained the basics of extended-capacity magazine design to the Ichord subcommittee as follows:

> *..the shorter the magazine is, the less necessity there is for a curved magazine, and vice versa...a 30-round [Stoner System] magazine is..curved..and a curved magazine is the only system where you can get ideal feeding conditions through the full complement of the magazine, because the ammunition is slightly tapered and this follows the natural curve. If you laid the cartridges out on a table, this would be the arc, if you stacked them up, that they would go.*

Despite the numerous modifications to which the original AR-15 had been subjected, the dimensions of the magazine well area had remained untouched since the earliest days, and it was soon found that it was not so simple to design an extended-capacity magazine for the M16A1. Colt's first 30-round M16A1 magazines *were* curved in an unbroken arc (fig. 406 no. 4), but a problem awaited them upon their trials issue: they simply would not fit into the magazine wells of many existing AR-15s/M16/XM16E1s.

In March 1966 Col. Yount reported that due to Colt's "inability to provide an operable 30 round magazine", the first few months' production of "Commandos" were to be issued with regular 20-rounders. However, the other problems of the next sixteen months somewhat overshadowed the magazine project. In July 1967 Lt. Col. Engle, the acting Project Manager, recorded that a product improvement test was "suspended due to deficiencies found in the magazines. Colt's Inc., is again reviewing the design and is scheduled to resubmit.."

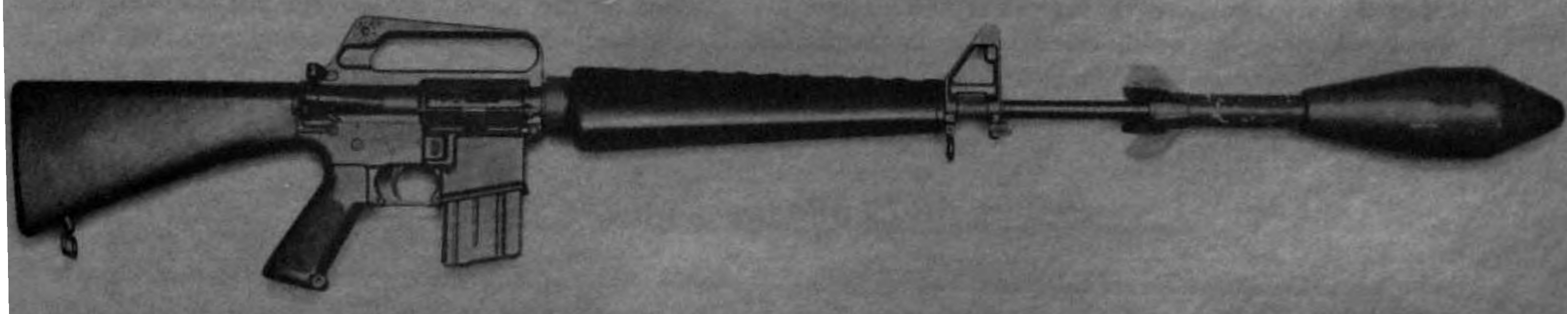
It appeared that the front of the magazine well of the rifle itself had not been too closely gauged or controlled in previous manufacture. In Gene Stoner's words "..at the time we didn't know better..I wish it [the capability to accept a fully-curved magazine] had been put into the M16 rifle.."

The design finally chosen, Colt's "firearm box magazine with straight end and intermediate arctuate portions" was the best possible compromise, built somewhat along the lines of the World War II 30-round M2 Carbine magazine. However, it was 1969 before 30-round magazines first became available for issue:

Project: rifles [week of] 10-14 June 1968

30-round magazine: *Colt's Inc., has signed a contract to produce 1,000 30-round magazines to be used in an initial production test. Delivery is anticipated in 6 1/2 months. A technical data package will be furnished by Colt's under the terms of this contract at no cost to the government. This initial quantity..will be produced on hard tooling, so that immediately following the successful conclusion of the..test, mass production may be initiated.*

The 40MM Grenade Launcher Attachment Project



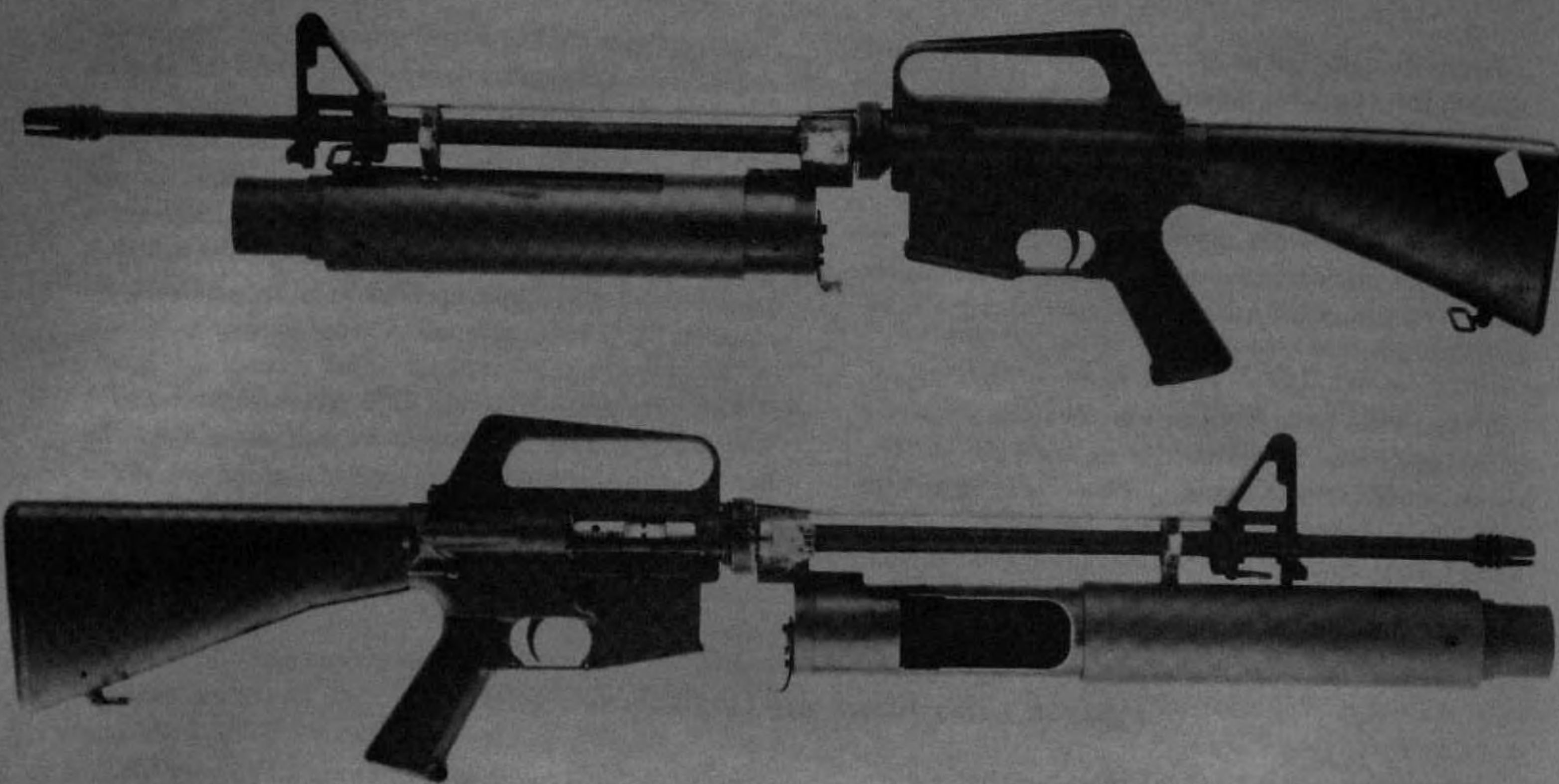
236 XM16E1 shown ready to fire an Energa-type rifle grenade. At Staff level, this concept of launching bulky grenades by means of dedicated grenade-blank cartridges was seen as counterproductive to standardized use of the M79/40mm grenade system, for which the SPIW program had already produced several "promising" launcher attachments.

The Early Days

As discussed at length in *The SPIW*, one of the main design advantages so expensively sought in that program was the capability of firing both "point-fire" flechettes and "area-fire" grenades from the same weapon. Although the SPIW itself did not materialize, the point-and-area-fire idea itself still offered tremendous increases in "man-weapon effectiveness". Early in the rifle program the concept was accordingly grafted onto the AR-15 as "a low-risk, high-payoff" bequest from the failing SPIW:

Project: AR-15 rifle [week of] 27-31 May 1963

Grenade launcher: *Work has been initiated to mount a SPIW type 40mm grenade launcher on the AR-15. This launcher will be the quick detachable type capable of firing the ammunition currently used by the Launcher Grenade M79. This launcher should be available for demonstration firing by 30 June 1963.*



237. Rob Roy's first model of an admirably simple, single-shot 40mm grenade launcher attachment for the AR-15. It was not adopted.

Above: left side view; sliding barrel and breech cover closed. Below: right side view; sliding barrel forward for loading.

Apparently the bolt closure debate and the "slamfire" problem kept everyone too busy over the summer of 1963 for them to attend to the development of the launcher. The next mention of the project did not come until November, when Lt. Col. Yount noted that CDC had furnished advance notice of their draft SDR (Small Development Requirement) for an AR-15 grenade launcher development project. After that, not much progress was made until the following spring, when the PMR reported a problem with funding:

Project: AR-15 rifle [week of] 25-29 May 1964

Grenade launcher: *..The AMC Deputy Comptroller stated that RTD&E funds are needed for this development. Since there are no RTD&E funds for the AR-15 program and no rifle funding in FY65 budget, it appears necessary (in keeping with the urgency of this project) to fund the development..as a separate task under the SPIW program. No further action can be taken by the project manager..pending..approval and funding.*

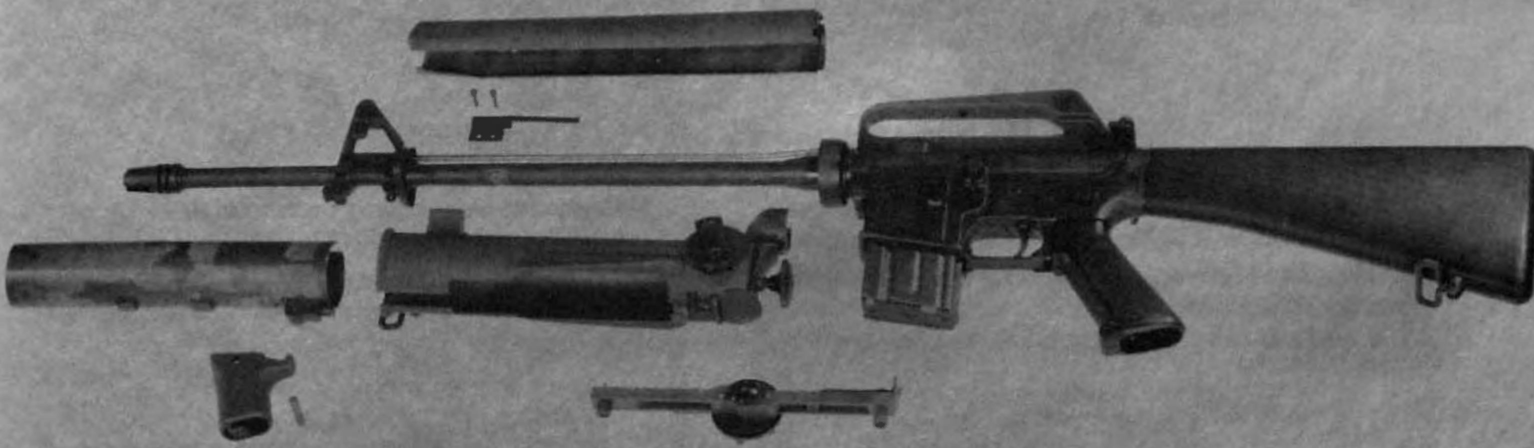
Introducing the Colt CGL-4

As noted in chapter 9, during the last week of May 1964 a "specially furnished XM16E1 rifle representing the first rifle for the Army under the FY64 contract" had been presented by Colt's to the Army's Chief of Staff, General Wheeler. At that time Colt's new CAR-15 series was also unveiled for General Wheeler, who "showed special interest in the Colt..40mm grenade launcher and stated that the Army had a definite requirement for such an item".

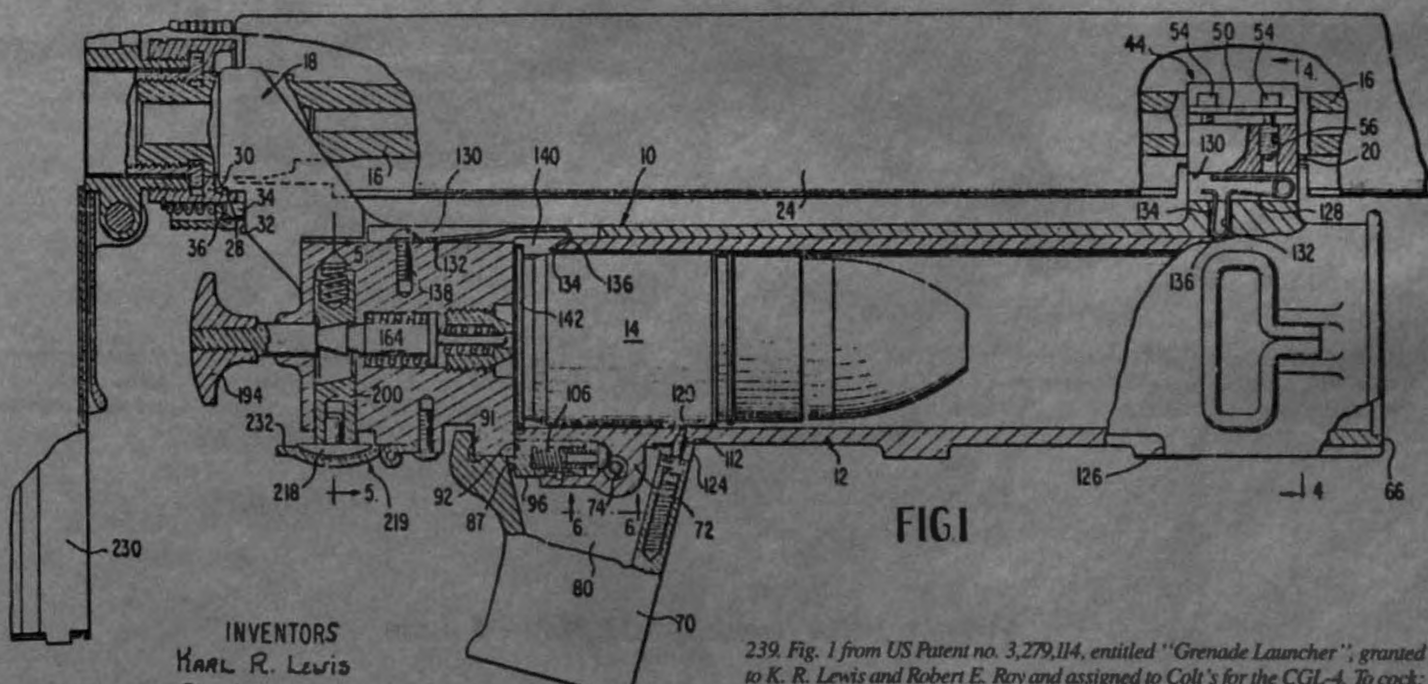
The following month it was momentously decided that it was unnecessary to design brand new launchers for the AR-15 when there were several types already under development in the SPIW program, and the draft SDR was accordingly cancelled. The PMR noted that AMC had been directed "to proceed to engineer the most suitable single-shot launcher from the SPIW program to adopt it to use with the XM16E1 rifle. Springfield Armory is being directed to select the launcher and adapt it.." In response to a written note from General Besson, stating "Let's get an independent review of the selection", an interesting followup memorandum continued,

..The Project Manager proposes to submit to TECOM, for test, at least two successful, complete, single-shot launchers, which are readily available. A third launcher designed by Springfield Armory is being considered for inclusion. The two successful launchers to be tested are the Ford Motor Company model which was used with the Springfield Armory SPIW prototype and the model designed by Colt's [then known as the CGL-4].

Another Springfield Armory launcher was considered and rejected in early design stages as having basic faults and insufficient advantages to pursue to completion. Still another single-shot launcher, designed by Aircraft Armaments for use with their SPIW prototype, is reported to have good possibilities, but has been rejected from current consideration, because it will not fire standard 40mm grenades, and thus involves ammunition development as well as launcher development..



238. An Army XM16E1 with Colt CGL-4 launcher disassembled, showing components. Note the early handguard.
Springfield Armory photo dated November 10, 1964.



INVENTORS
Karl R. Lewis
Robert E. Roy

BY Lindsey, Prutzman and Hayes
ATTORNEY

239. Fig. 1 from US Patent no. 3,279,114, entitled "Grenade Launcher", granted to K. R. Lewis and Robert E. Roy and assigned to Colt's for the CGL-4. To cock: "the button 194 is pulled rearwardly causing firing pin 164 to move rearwardly ..[causing] the sear [to] drop onto ramp 182..the..button may be released with the firing pin 164 remaining cocked." To fire: "..push against the outer ledge 232 of the safety hinge 219. The hinge will resistingly move out of the way..thus exposing the button 218 for actuation of the sear 200 to effect release of firing pin 164".
US Patent Office

The Aircraft Armaments, Inc. (AAI) SPIW launcher mentioned above was designed around AAI's revolutionary DBCATA (Disposable Barrel and Cartridge Area Target Ammunition), which is discussed at length in *The SPIW.* While it is true the DBCATA was not compatible with standard M79-type 40x46mmSR grenades, each DBCATA round had the distinct advantage of being, in effect, its own launcher, doing away with most of the bulk and weight of a separate launcher altogether. Only a simple base-plate was required, onto which each thick-walled, internally-rifled DBCATA cartridge was clipped prior to firing.

In any event, the Colt CGL-4, firing standard M79-type 40mm grenades, was chosen as the most promising launcher for attachment to the M16/XM16E1. A contract was signed in March 1965 to procure 30 of these Colt launchers for Engineering and Service tests. Unfortunately, as we shall see, the CGL-4 was a complicated design: as is so often the case with weapons rushed to completion in wartime, a litany of chronic problems was to dog the complex CGL-4 throughout its short life. These difficulties commenced soon after the tests began:

Project: rifles [week of] 10-14 May 1965

Grenade launcher attachment: *Air Force began tests of 40mm, detachable [Colt] launchers on 12 May..at Lackland Air Force Base. Some trouble was encountered due to weak extractor springs, and Colt's is now rushing new ones to both Air Force and Army test sites. One launcher housing broke apparently due to foreign material in the breech. This.. is being investigated to determine whether a modification of the housing is necessary for added strength. Tests at Aberdeen and Fort Benning are scheduled to start next week upon completion of safety certification.*

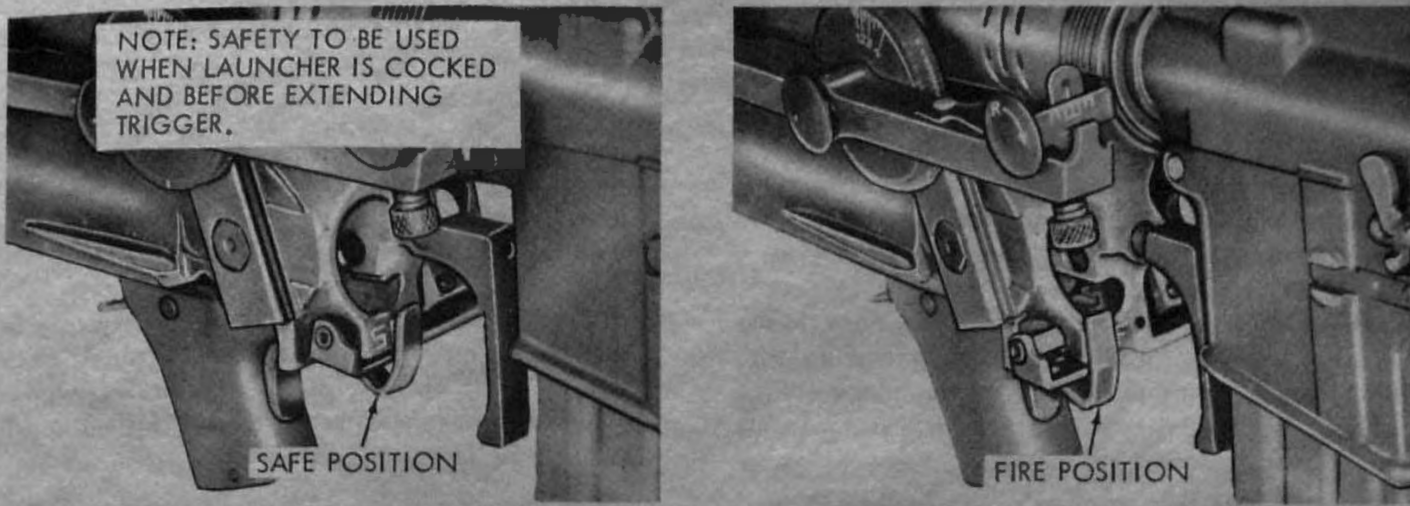
The CGL-4 Becomes the XM148

240. Right side view of M16A1 serial no. 886104, fitted with a cutaway version of Colt's later, "improved" model of the CGL-4, which was assigned the military designation XM148. Note the vented handguard. The 3-lb. XM148 launched standard 40mm grenades at a rate of 12 rounds per minute, producing a muzzle velocity of 240 fps from its 10" barrel.
Smithsonian Institution collection

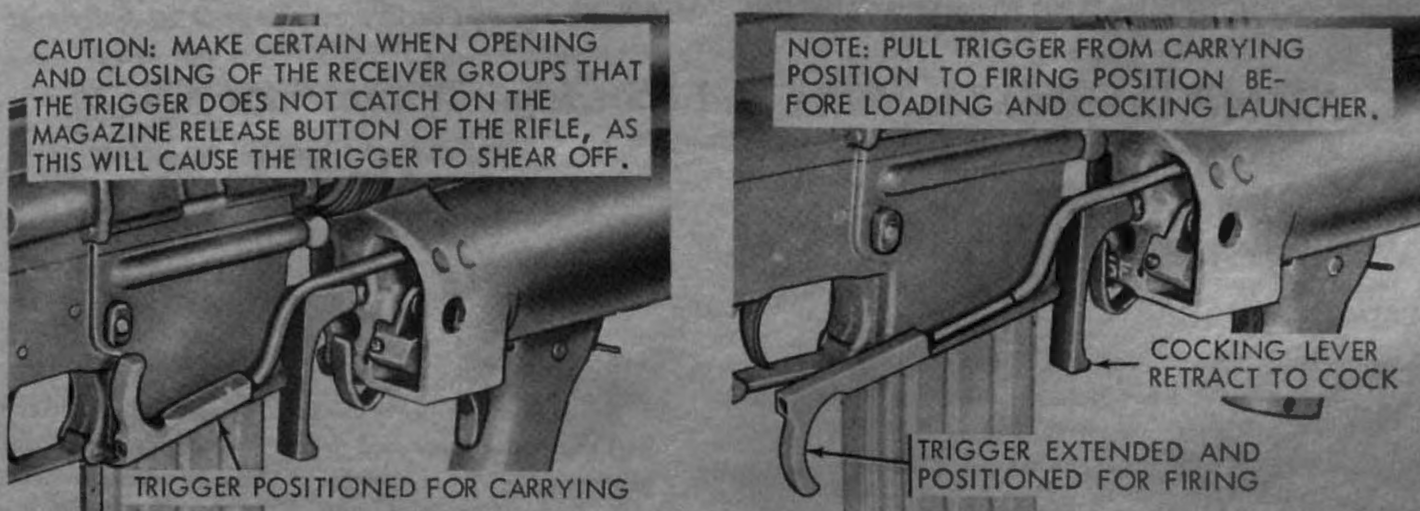
An omimous note introduced the first use of the CGL-4's new Army designation, the "XM148":

Project: rifles [week of] 31 May - 4 June

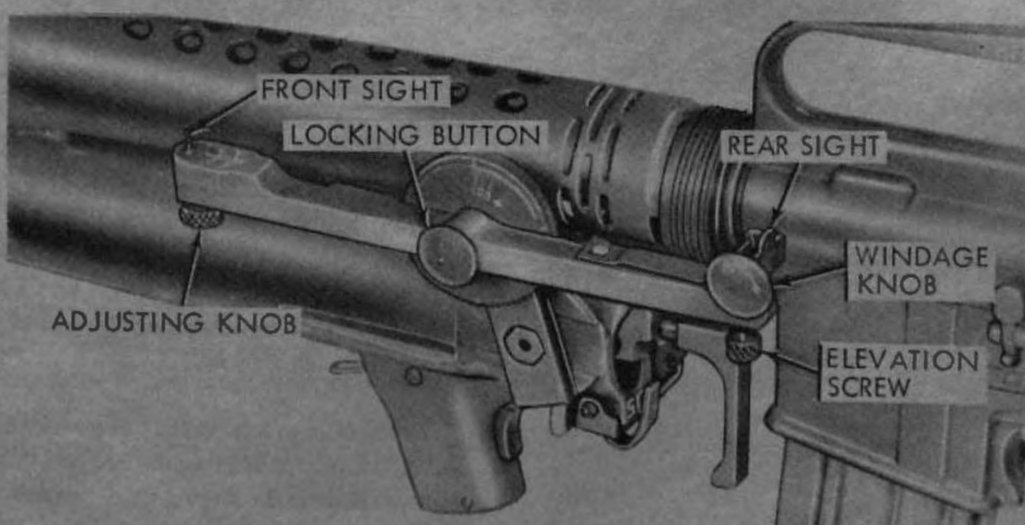
40mm Grenade launcher attachment: *ET/ST of the 40mm Grenade launcher XM148 has been suspended due to cracking in critical areas of two of the hand cast aluminum housings. Future launcher development and test activity will hinge on what can be done to provide adequate housings. This problem will be coordinated with Air Force in view of their intense interest in this program, and a decision reached after review of the factors which caused the breakage.*



A - Safety



B - Trigger and Cocking Lever



C - Sight

241. Details of the complex sighting, safety and trigger systems of the XM148, from an early combined services tech manual (TM 9-1005-249-14; T.O. 11W3-5-5-1; NAVWEP O.P. 3333) dated June 15, 1964. Over 34,000 XM148 launcher attachments were produced before the design was abandoned as unsatisfactory.

Courtesy James Alley

By the following week, the grenade launcher project had been bumped right up to the top of Lt. Col. Yount's significant action report:

> 40mm Grenade launcher attachment: *Engineering and Service tests are still under suspension due to cracking of launcher housings. Investigation revealed grain structure problems as a result of casting technique and alloy composition. Colt's has agreed to replace all housing castings with ones of a different alloy at no cost to the government and to reassemble all launchers when the new castings, with improved strength, are ready..*

Safety re-certification of launchers fitted with the new castings was completed in the fall of 1965, and testing continued with the PMR noting hopefully in mid-October "Review of test results on 30 September indicates deficiencies found in testing can apparently be corrected."

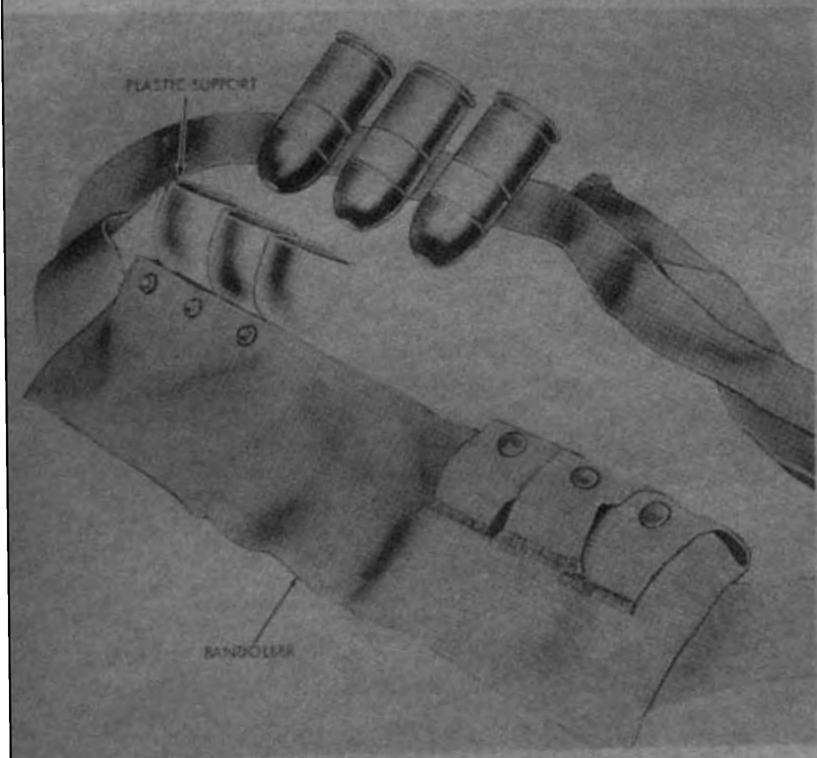
Meanwhile, in spite of differences of opinion between the Army Staff and Headquarters of the Military Assistance Command Vietnam (MACV) as to just what a grenade launcher attachment should look like and do, Lt. Col. Yount put together some numbers on "a firm operational requirement" for the XM148. The US Air Force, eager to field the new launchers, submitted an interdepartmental request (MIPR) in mid-December for 7,000 XM148s.

Early in the new year the PMR prepared the following special memorandum for General Besson on the status of the project:

XM148 Grenade Launcher and Cartridge 40mm Shot XM576

2 February 1966

> *..Limited Production quantity of 10,500 [XM148 launchers] for the Army was granted on 3 January 1966...This figure was based on requirement information furnished by COMUSMACV.*
>
> *A cartridge 40mm shot XM576 (shotgun type) is currently being developed...Delivery of a safety certified interim round with an effective range of 35 meters is scheduled..*



242. Fig. 5-3 from TM 9-1005-249-14: supply and transport of 40mm grenades for the M79 and XM148.

Before manufacture began in earnest Colt's had to tool up, and the Army proceeded to test a small number of initial production XM148 launchers as a final, standard precaution. A quantity of 25 was agreed upon, which for the first time were to feature a stronger housing made from a subcontracted aluminum forging. Over the summer a further hitch developed when the forging dies cracked and had to be remade. Meanwhile, Lt. Col. Yount announced on 29 June, the day following the signing of the contract for 2,815 Colt "Commando" CAR-15 sub-machine guns, that Colt's had "signed the contract for 19,236 XM148 Grenade Launchers." Immediately, another problem appeared. The subcontractor for the XM148 housing forging, Kaiser Aluminum of Erie, Pennsylvania, was also working on the "DX rated 904 Fuze Body Program" for the Air Force's 750-lb. bomb, which had a higher priority than did the grenade launcher forgings, *and* which utilized the same production equipment.

In response to a pencilled "hastener" from General Besson, AMC's Director of Procurement and Production, Col. Woolwine, explained the forging delay problem, in the process introducing yet another:

The DX rated Fuze Body for the M904 Fuze, 750 lb. Bomb and the barrel forging for the XM148 Grenade Launcher are competing for the insufficient production capacity of the Kaiser Aluminum Company. Since the..fuze takes precedence over the..launcher, the production of barrel forgings had to give way for two months. Available forgings will permit assembly of the first 1,500 launchers.

..The first 25..launchers accepted in July have failed the IPT (Initial Production Test) due to failure of the sight to hold position. Corrective measures are being investigated with Colt's. However, this will delay acceptances and may become a controlling factor, outweighing the forging shortage. A solution to this problem is not currently available...schedules have been adjusted to show completion of the current order for 19,236 units by June instead of February, 1967.

This in turn prompted an exasperated General Besson to scrawl: "I can't see how a loose sight can take 4 months to solve."

On 8 August the Project Manager announced that the Initial Production Test had indeed been suspended, due to "movement of the sight during firing of launcher and/or rifle". The launchers and sights were returned to Colt's for "corrective action", and the tests held in abeyance until "Colt's demonstrates that the deficiency has been corrected". The sights were reworked, and "the inadvertent fire deficiency which caused the second suspension" of the IPT was also overcome. In September, TECOM pronounced the XM148 "suitable for field issue when restricted to operating temperatures of -25°F to +155°F", but it seems Col. Yount jumped the gun somewhat in reporting first issue of the XM148: "Initial shipment, representing September's production, of between 750 to 1,000 launchers will be made prior to 10 October 1966".

Alas, it was not to be so easy after all:

XM148 Grenade launcher: *To overcome a marginal risk of misfires which existed in the launchers tested during the IPT, Colt's Inc., redesigned the launcher firing pin and spring. Evaluation of the improved firing pin and spring is presently in progress at Springfield Armory..*

Here General Besson again intervenes, "Seems to me work should be on XM148 rather that M79..What can we do about the sight?"

At last Col. Yount was able to announce delivery to the field,

SPIW Program: *Representatives of AAI Corporation will brief the Project Manager..on 21 October on the results of the feasibility study of combining the Disposable Barrel Cartridge Area Target Ammunition (DBCATA) with existing standard rifles, and redesigning the M79 to fire DBCATA rounds..*

but got little applause from General Besson. Unfortunately, the first issue of XM148s coincided with Lt. Col. Underwood's return from Vietnam, where the Army was experiencing grave loss of confidence in the XM16E1:

Project: rifles [week of] 12-16 December 1966

XM148 Grenade launcher: *The first shipment to Vietnam of 1,764 launchers plus repair parts was made on 15 December 1966...A new equipment training team consisting of two Weapons Command maintenance technicians and two representatives from Colt's, Inc., has been organized...The team will depart for Vietnam on/about 15 January..[General Besson's pencil interrupts: "They should have been there to meet the plane!"]*

Problems with the XM148 in Vietnam

By the end of January 1967 Colt's was well ahead of its scheduled XM148 deliveries, having produced a total of 10,862 launchers. The following month the launcher assistance team returned from Vietnam, whence the early word was that the XM148s were performing well under combat conditions, and although "some improvements" had been suggested, "the tactical advantage of both the point fire and area fire system was highly endorsed". This situation was short-lived, however:

Project: rifles [week of] 13-17 March 1967

XM148 Grenade launcher: *..Preliminary reports from Vietnam indicate three potential problem areas with the XM148:*

- sight mount: numerous parts make it difficult to repair at the organizational level and its location on the weapon causes it to snag on brush or clothing.

corrective action: present efforts to develop a new sight will eliminate the problems..

- cocking: too much force is required to cock the weapon.

corrective action: Colt's is prepared to submit an RTA on an improved sear which they contend will reduce the cocking force from 30 lbs. to 20 lbs. It is doubtful that further reductions could be made without a complete redesign of the firing mechanism.

- trigger: numerous parts made assembly and disassembly difficult..

corrective action: Colt's is..working on a possible solution, but no corrective action has been taken to date. A major redesign of the trigger and firing mechanism may be required to bring about significant improvements in this area..

Problems with the sights continued to dog the launcher project:

Project: rifles [week of] 20-24 March 1967

XM148 Grenade launcher: *The..sight development program continues to have difficulties...A Colt design error on the cam angle of the elevation brackets originally caused excessive deflection and range errors...After resumption of firing, the deflection errors at 350 - 400 meters persisted... Should the Analytical Lab [at Aberdeen] determine that the sight contains a design deficiency, Colt's will require one or two weeks to make the necessary corrections...The overall impact of this slippage is that the new sights cannot be adapted on current grenade launcher production...the new sight should be available for production in FY68 buy of XM148 grenade launchers..*

The XM148 Craps Out

The following month a three-man team, including Colt's "Koni" Ito, was again sent to Vietnam at the request of HQ, USARV, to assist with chronic problems being experienced with XM148s in the field; namely, the sights, which were improperly calibrated, bulky and easily knocked off their "zero"; the excessive force necessary to cock the device; and the complicated trigger mechanism which made field servicing a nightmare. The team's efforts soon proved to be in vain, however:

Project: rifles [week of] 8-12 May 1967

XM148 Grenade launcher: *A telephone call from the XM148..Technical Assistance Team presently in Vietnam has given preliminary information on the ACTIV evaluation of the XM148...The..evaluation is as follows:*

- The XM148..is unsatisfactory for use in the Vietnam environment.

- They are recommending the XM148 be withdrawn from troops and replaced with the M79 launcher.

- They recommend a vigorous program..to develop a new launcher with the same principle as the XM148 (i.e. mounting directly on the rifle)..

- In consideration of the above stated facts, future plans are in doubt..

The Army's Grenade Launcher Attachment Development (GLAD) Program

For Colt's, the failure of their proprietary XM148 in the field was a severe embarrassment. Col. Yount reported in June 1967 that the firm was "crashing the design of modifications to the XM148 in an attempt to meet, on a retrofit basis, the requirements implied in the ACTIV report". But Colt's had lost the initiative, and meanwhile the grenade launcher project had become a full-fledged program: the Army had formally let it be known that they were "in the market" for a new launcher design:

Project: rifles [week of] 10-14 July 1967

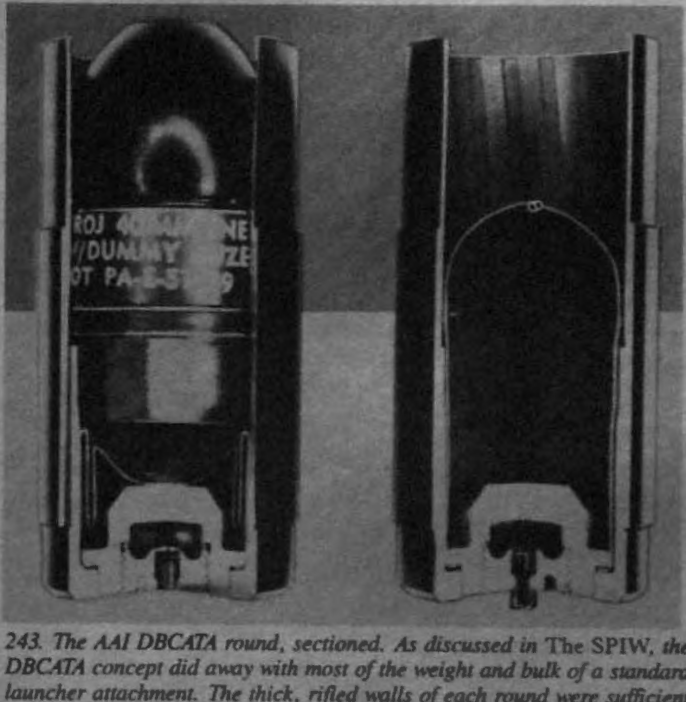
Grenade launcher: *Response from private industry concerning the projected industry briefing (for development of conventional launcher) to be held at Rock Island on 18 July 1967, has been favorable. Of the 17 firms contacted, seven have formally indicated their interest. These were AAI Corporation, Harvey Aluminum, Aero Jet General, Aeronutronic Division - Ford Motor Company, United Aircraft, Chrysler Corporation, and Colt's..*

The AAI DBCATA Grenade

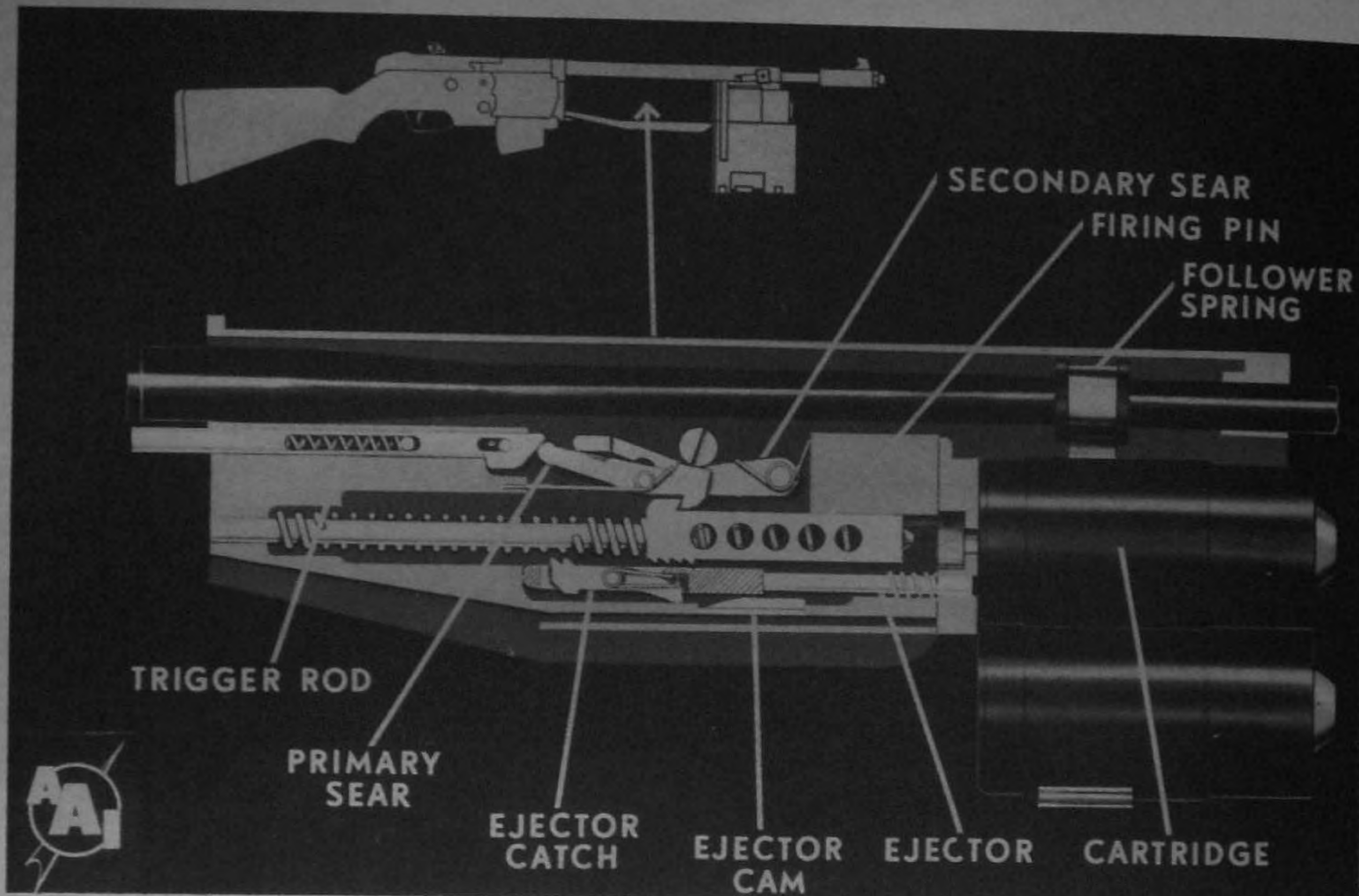
AAI Corporation (formerly Aircraft Armaments Inc.) had by this time developed several different single-shot, pump-type and "harmonica" semi-automatic 40mm launchers as part of the SPIW program, as well as inventing and producing the serial flechette itself, *and* the launcherless DBCATA grenade (fig. 243).

Earlier in July the acting PMR, Lt. Col. Engle, had recorded AAI's entry into the single-shot launcher attachment program as follows:

..AAI, a potential contractor, visited this office informally, concerning their concept for the pump-action, single-shot, conventional launcher which had been shown to General Besson. [They] had a wooden mock-up of an exterior configuration only. There were no functioning internal parts. When asked about delivery schedules, the contractor's representative stated that they could probably handcraft one to four tool-room models suitable for firing in about six months. He further stated that test hardware suitable for TECOM evaluation testing (about 10 to 20 prototypes only) with drawings would take about one year...It is believed that the.. estimated delivery schedule was an unofficial, but honest, engineering appraisal. Past experience with this particular firm usually indicates that their forecasts are more likely to be optimistic than conservative as to time-frame..



243. The AAI DBCATA round, sectioned. As discussed in The SPIW, *the DBCATA concept did away with most of the weight and bulk of a standard launcher attachment. The thick, rifled walls of each round were sufficient to contain the forces of firing the (standard M406 HE) 40mm projectile.*
Left: before firing. Note the folded cup seal.
Right: after firing. Note the rifled walls and the expanded cup seal, which contained the propellant gases and gave the DBCATA the added advantage of being smokeless and flashless. Note also the piston primer, protruding from the (rimless) base of the thick-walled DBCATA case. Muzzle velocity: 245 fps. Maximum range: 400 meters.



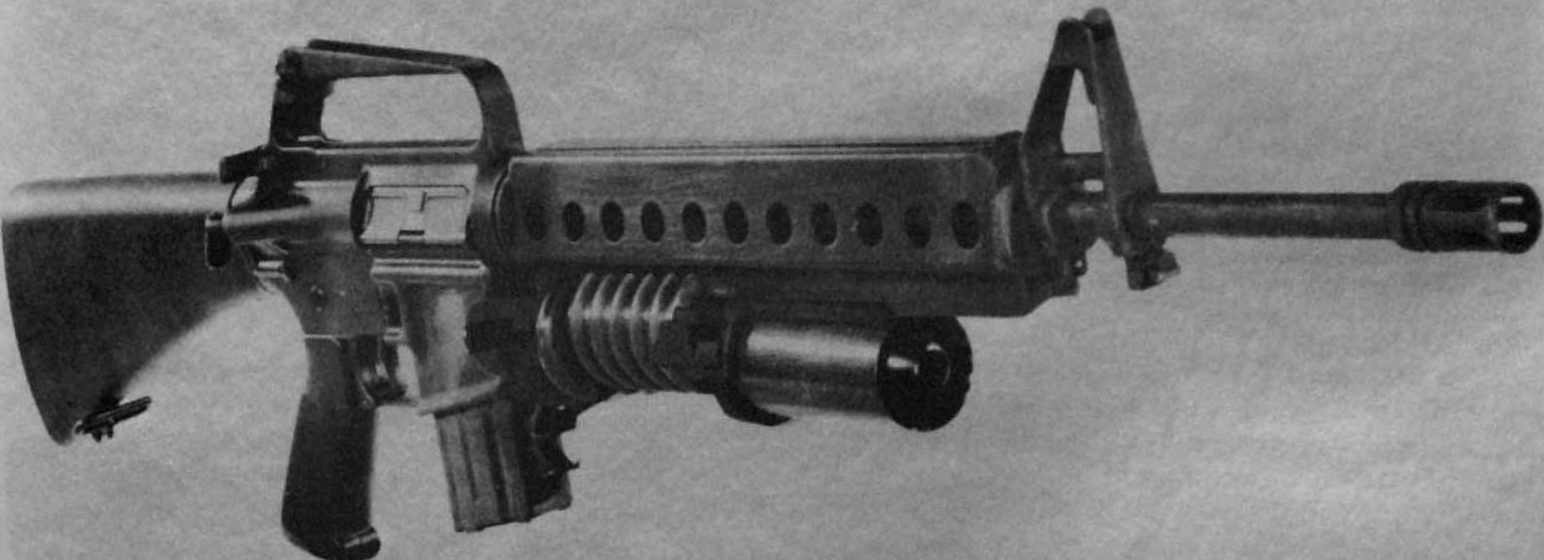
244. The AAI DBCATA, while not adopted for reasons of cost and non-interchangeability with the M79, was certainly one of the best of the many incredibly ingenious ideas put forth during the two decades of the SPIW program. In this diagrammatic view of the semiautomatic *DBCATA system as featured on an early AAI SPIW, note the (rimless) rounds held by the simple coiling band of the follower spring. With the proper selector lever position engaged, pulling the SPIW's regular trigger (another SPIW specification) moved a linkage which forced the DBCATA trigger rod against the primary sear, releasing the firing pin and firing the round. The cup seal (fig. 243) expanded to contain the (smokeless and flashless) explosion, while the piston primer propelled the firing pin strongly rearward. The teeth on the firing pin passed over the teeth on the (spring-loaded) ejector catch on this rearward stroke, but as the firing pin spring reasserted itself, the teeth made contact and the final forward movement of the firing pin (before being caught in the cocked position by the sear) propelled the ejector forward, ejecting the spent DBCATA case straight ahead. The ejector spring then took over, returning the ejector to its resting position, while the ejector cam cleverly avoided any further contact between the two sets of teeth.* *Courtesy AAI Corporation*

First use of the acronym GLAD came in the middle of September 1967, by which time the program had progressed to the point of contract awards to three firms; AAI, Philco-Ford's Aeronutronics Division, and Aero Jet General.

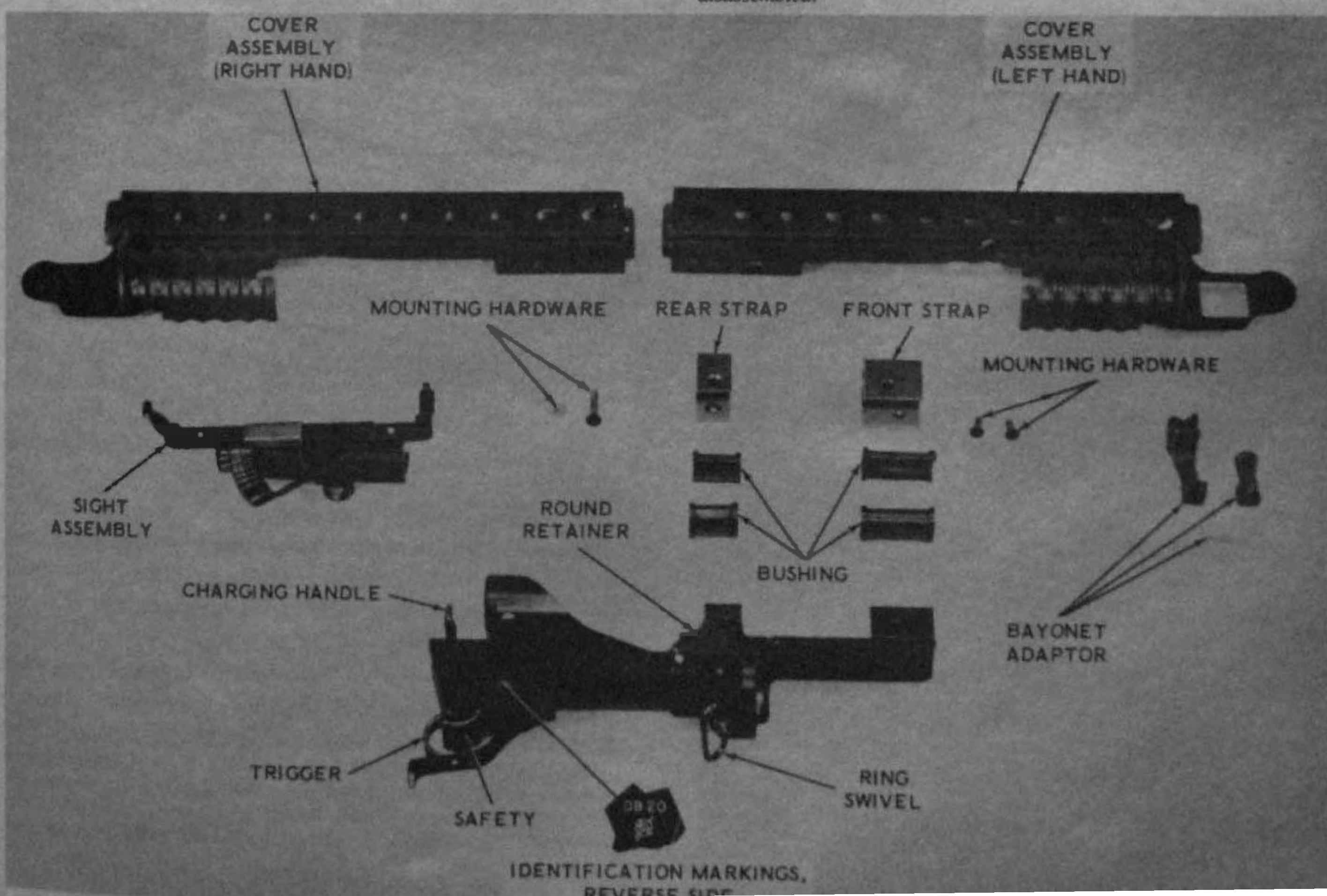
> *The ACTIV [Army Concept Team in Vietnam] evaluation and subsequent ACSFOR concurrence has stated the XM148 ..was unsatisfactory for combat deployment in Vietnam. An ACSFOR message to USARV requested information concerning employment of the XM148 in various alternate roles, such as base camp defense, etc. USARV has responded they have no requirement for the XM148..in Vietnam. Therefore, disposition instructions of launchers currently in Vietnam are currently being requested..*

Ironically for Colt's, the week of the three new contract announcements coincided with a final word in the PMR's report on the XM148s still in Vietnam, which constituted "the majority" of an already-delivered 27,400 XM148s, against a contracted total order of 34,076:

245. *Right side view of an M16A1 rifle equipped for single shot launch of AAI's revolutionary Disposable Barrel and Cartridge Area Target Ammunition (DBCATA).*
Above: DBCATA launcher assembled to rifle.
Below: DBCATA grenade clipped onto launcher plate.
Courtesy AAI Corporation

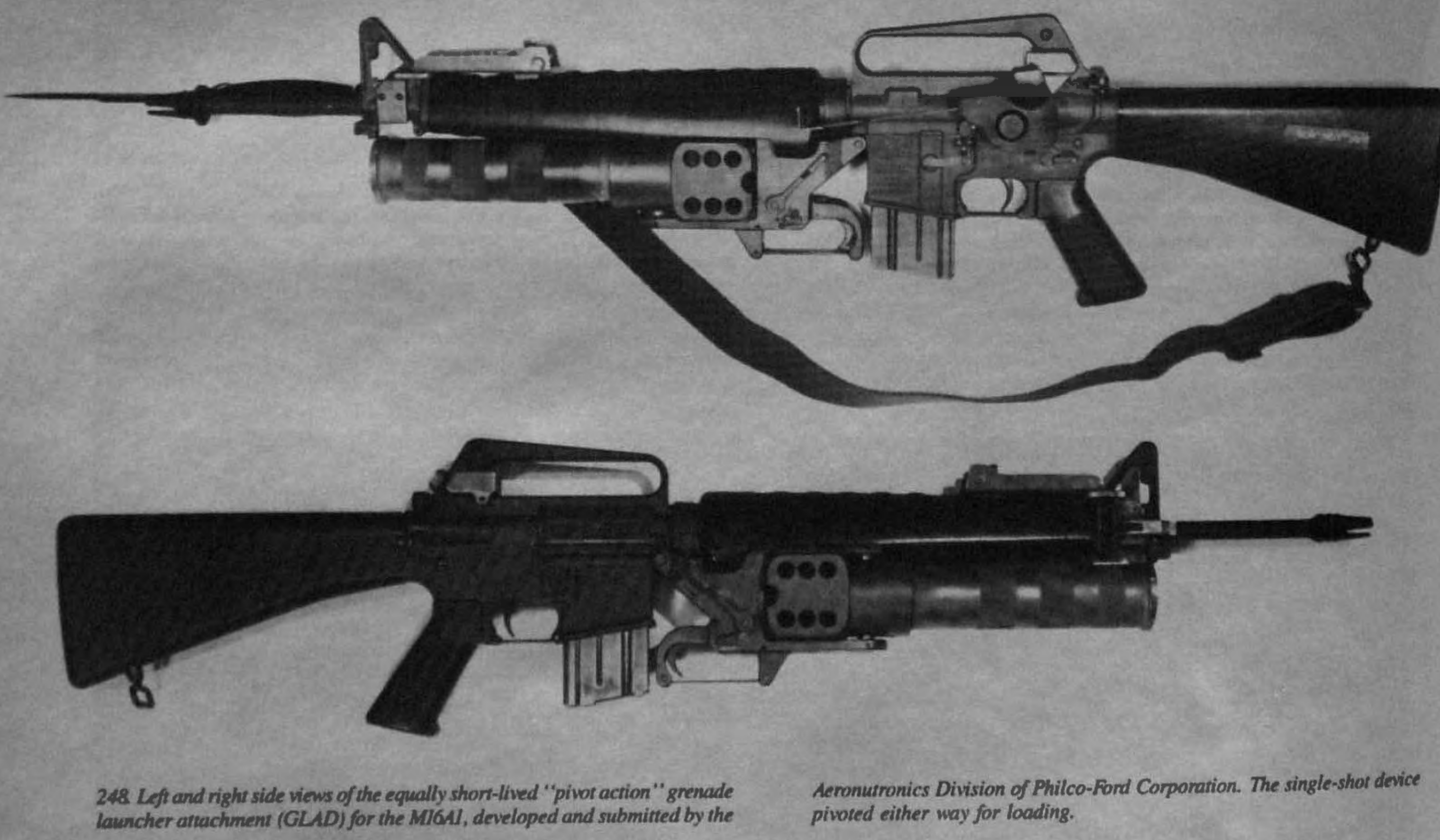


246. *AAI (single shot) DBCATA launcher attachment for M16/M16A1 rifle, disassembled.*



The AAI, Philco-Ford and Aero Jet Launchers

247. The short-lived "delayed-blowback, inertia-lock" grenade launcher attachment (GLAD) for the M16A1, designed and submitted by Aero-Jet General Corporation. After watching a demonstration of some first-generation SPIW prototypes, Colt engineer Rob Roy had been moved to comment that the combination of point- and area-fire capability in the same weapon was, from the human engineering standpoint, "the poorest thing imaginable". It seemed the M16A1 was faring little better, at least at the hands of Aero-Jet General.



248. Left and right side views of the equally short-lived "pivot action" grenade launcher attachment (GLAD) for the M16A1, developed and submitted by the Aeronutronics Division of Philco-Ford Corporation. The single-shot device pivoted either way for loading.

As had been the case in the SPIW program, each of the new firms was allowed to take a different approach to the design of their 40mm grenade launcher. In Lt. Col. Engle's words, AAI proposed a "conventional pump action concept", Philco-Ford a "pivot action concept", and Aero Jet a "delayed blow-back inertia-lock concept". Delivery of prototypes for the Engineering Design Test was set for 1 May 1968.

The Short-Lived Colt CGL-5

249. Colt's last-minute CGL-5, which they hoped would save the day after the acute embarrassment of the failed XM148. US Patent no. 3,507,067 was granted to Colt engineer Henry A. Into for the CGL-5, described as a "Grenade launcher Having a Rotatable Forwardly Sliding Barrel and Removable Firing Mechanism".

While Colt's presented the double-action CGL-5 as a great improvement over its predecessor, AMC had already been favorably impressed by the AAI "pump" launcher (fig. 250).

The first PMR report of 1968 announced a last-minute attempt by Colt's to get back into the running by offering the government 20 examples of an improved "CGL-5" launcher free of charge. Lt. Col. Engle reported "considerable discussion" concerning the Colt proposal, but in the end it was decided that the CGL-5 did not offer the potential which had already been displayed by other launchers in the program. With "no particular advantages and with proprietary rights to consider", Colt's offer was declined.

The AAI XM203 Takes the Lead

Testing began on schedule with 20 prototypes each from AAI and Philco-Ford's Aeronutronics Division on 1 May 1968. By July, Lt. Col. Engle reported that the AAI pump launcher was well in the lead:

> *The pre-IPR (in-process review)..was conducted at Hqs, AMC on 8 July 1968. The AMC position..is to continue AAI pump launcher into Phase II of the GLAD Development Program; to continue the development of the Aeronutronics battle sight; to develop..a "prism-type" sight and a "sliding scale, post-type" sight; and to conduct troop acceptance tests..immediately after successful ET/ST and prior to type classification as standard..*

The AAI pump launcher was soon "unanimously selected based on superior performance and predicted lower cost in production", and a letter contract was awarded on 2 August. By early November the AAI design had become the second grenade launcher to be officially awarded an XM number:

250. A prototype of the AAI-designed, single-shot 40mm "pump" launcher, undergoing trial during the GLAD program. Note the serial number, "AA22". The AAI launcher was by far the most logical and versatile design submitted, and held the loaded weight of the combination weapon (20 rounds of M193 ball and one M406 grenade) to 11 lbs. *Courtesy AAI Corporation*

251. Demonstrating its versatility, AAI pump launcher prototype serial no. AA21 is here shown mounted on an XM177E2, with AAI quadrant sight mounted on rifle carrying handle. Overall length (with stock telescoped): 29.75". Note the early, fully curved 30-round rifle magazine (fig. 406 no. 4).

Courtesy Lt. Col. Frank Conway

Project: rifles [week of] 4-8 November 1968

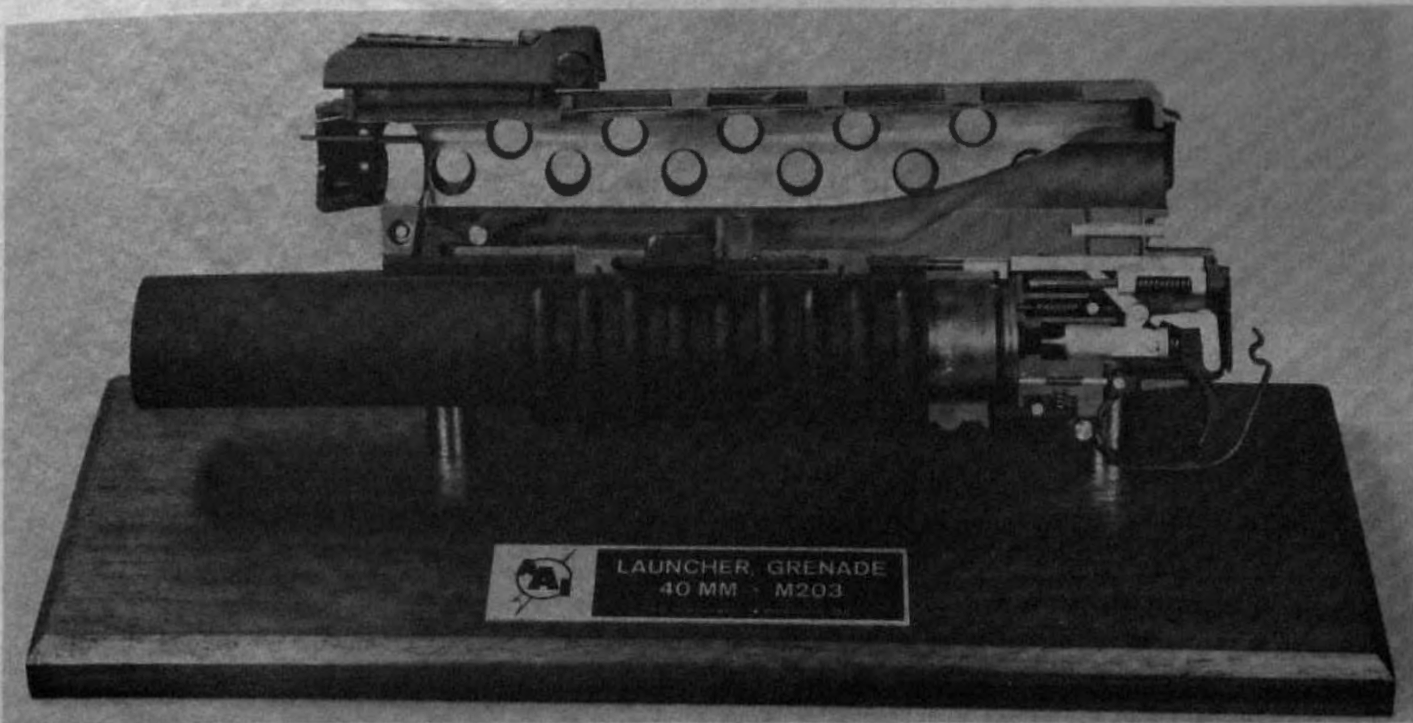
GLAD (XM203)

Contractual action to procure 500 each grenade launchers for SEA test will be formalized week of 10 November...AAI Corporation delivered six..of their two prism sight design and four..of their improved quadrant sights to Fort Benning 4 November.

A wooden mockup of a stock to which the XM203 can be attached for use as a separate weapon system without the rifle has been completed by AAI..

The Army Adopts the M203

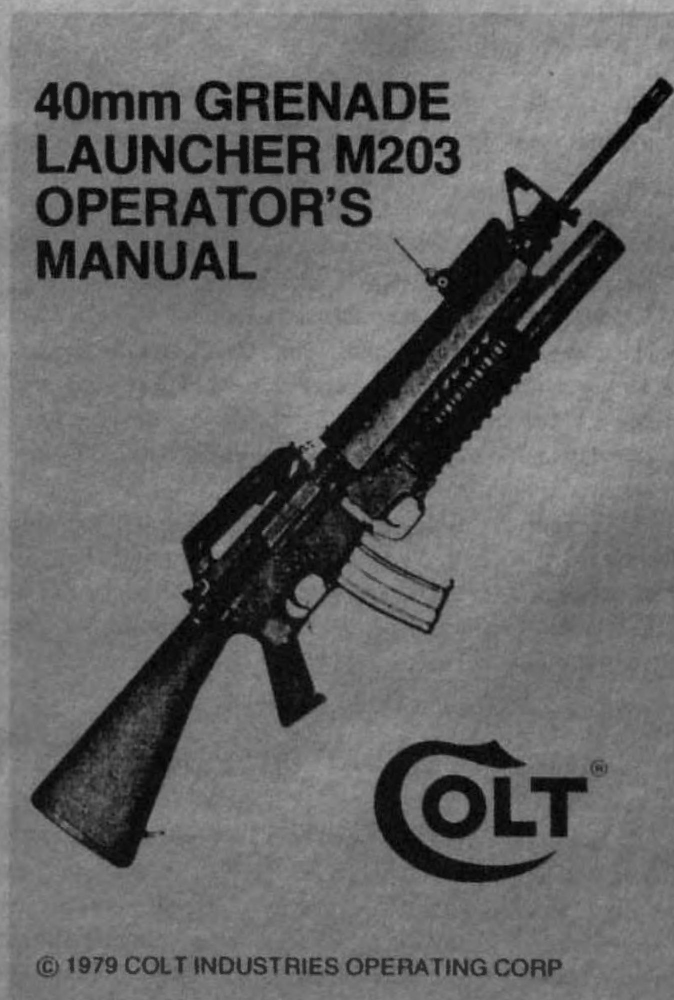
252. Right side view of the M16A1/M203 combination, showing the barrel forward and a grenade being inserted. Extraction takes place on the forward stroke of the manually-operated barrel, and as it is closed on a fresh round the mechanism is automatically cocked. Note the special front swivel and the raised battlesight, mounted on the special handguard.



253. Cutaway demonstration model of the AAI M203 grenade launcher attachment (GLAD). Courtesy AAI Corporation

With the AAI "wooden mockup" dying what appears to have been a natural death, a design freeze was placed on the XM203 launcher itself early in December 1968, and there followed a hurried authorization for AAI to build 600 XM203 launcher attachments equipped with the AAI battle sight for extended tests in Vietnam. Production of the successful AAI M203 design began in 1969. Thus had passed a full six years since the grenade launcher attachment project began as an offshoot of the SPIW program.

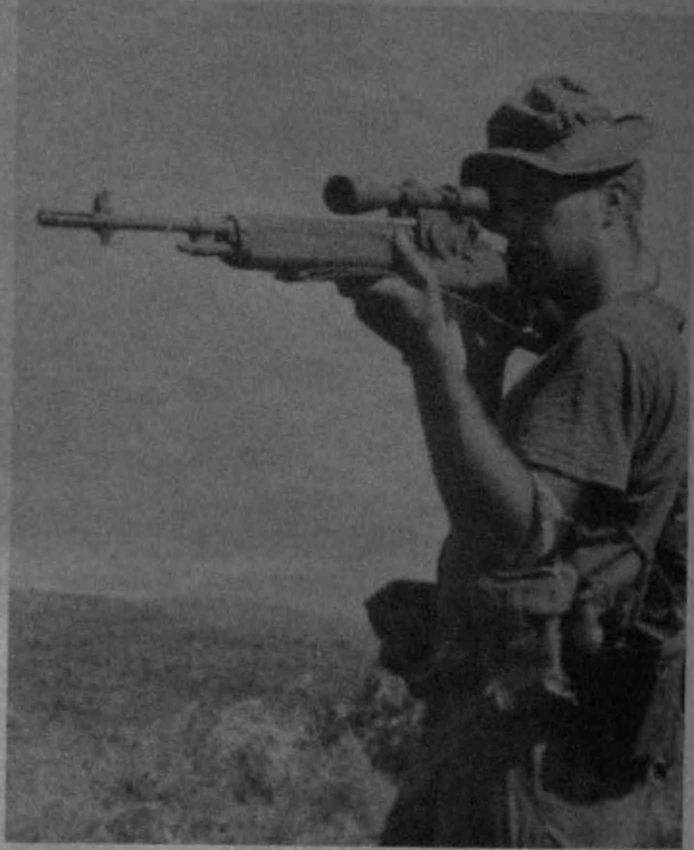
AAI Corporation was and remains essentially a research and development company, like Fairchild's ArmaLite Division had been. As such AAI was not really equipped for the mass manufacture of its brainchildren. Ironically, once the M203 was adopted, AAI's circular twin-arrow logo was supplanted by that of Colt's prancing horse. Colt's received all subsequent production contracts, and by the end of 1986 had manufactured more than 250,000 M203 grenade launchers.



254. Cover of M203 Operator's Manual from Colt Industries. Colt's has produced over 250,000 M203s.

Snipers in Vietnam

As discussed in *US Rifle M14*, a semi-official program to equip and train Snipers was hastily put in place during the period 1966 to the end of US involvement in the war. Beginning with M14 rifles fitted at Rock Island Arsenal with World War II-vintage M84 scope sights, the Army's sniper rifle evolved into the Marksmanship Training Unit's glass-bedded and accurized version of the National Match M14, called first the "M14 (MTU-NM)". The MTU further improved the system with the newly-developed Leatherwood/Redfield 3-9x Adjustable Ranging Telescope (AR TEL) and, where possible, one of the noise and flash suppressors discussed below. This unorthodox but highly effective M14 "package" was officially designated the M21 in 1972.



255. An American Sniper-instructor scanning the Mekong Delta through the 3-9x Leatherwood/Redfield automatic ranging telescope (AR Tel) mounted on his glass-bedded M21 (US Rifle M14).

US Army photo courtesy Peter Senich

In some cases it made sense to adapt the ideas coming out of the various units' in-country Sniper-Instructor programs to the M16A1. As with the development of the M21, the largely "ad hoc" unofficial M16A1 enhancement projects waxed and waned, reflecting first the buildup and then the de-escalation of the war:

Project: rifles [week of] 28 June - 2 July 1965

Infra-red weapons sight: *Units equipped with the XM16E1 rifle are presently unable to mount the standard infra-red weapons sight on the...rifle. Until such time as a mounting bracket is available, these units have retained M14 rifles for use with the infra-red weapons sight. On 25 June the Project Manager Rifles [Lt. Col. Yount] and the Project Manager Night Vision mutually agreed that the development and procurement for a mounting bracket would be handled by the Project Manager Night Vision. In order to cope with the immediate situation, a prototype bracket...will be provided to these units by the Third Quarter FY66.*

A full year to develop a mounting bracket was too much for General Besson, whose pencilled "Get together with PM Night Vision and revise this estimate" had the desired effect: "..As a result of expedited effort the mounting brackets are to be in the hands of troops by 10 September 1965". General Besson followed up again on this with "Make sure they are airlifted to Vietnam and make sure..units are not lost in theater".

Telescopes for the M16A1

As noted, Col. Yount had had curiously little to report upon his return from Vietnam, whence he had gone in response to Lt. Col. Underwood's telephone message regarding the "unbelievable" condition of the rifles there. One thing he did mention upon his return in late November 1966 was that some troops and officers interviewed had expressed a need for telescopic sights and mounts for their XM16E1s. This had resulted in an order from General Nelson M. Lynde to the PMR to take charge and "serve as the central focal point for..required actions on rifle scopes and mounts within AWC".

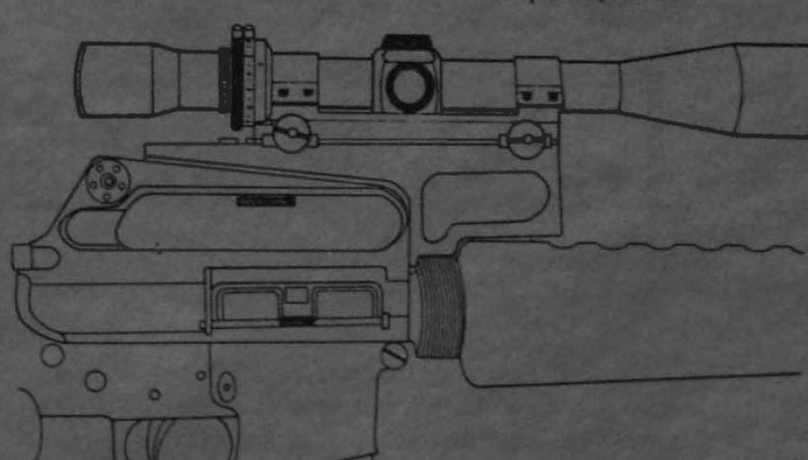
Accordingly, four months later Col. Yount reported "384 of Colt's Realist telescopes [fig. 265] to be mounted on M16A1 rifles..arrived in-country on 15 March 1967. The telescopes will be evaluated by..USARV in conjunction with the 125 accurized M14 rifles/M84 telescopes which were shipped from

256. Colt's model 655 "High Profile" Sniper version of the M16A1 with a later Leatherwood/Realist 3-9x ranging telescope mounted on the carrying handle, and fitted with a Sionics noise and flash suppressor (discussed below).
Courtesy the late John (Jack) Fernlund

257. Left and right side views of Colt's model 656 Sniper Rifle, with Leatherwood/Realist telescope sight mounted on a special, handleless upper receiver. Lower receiver appears unmodified (serial no. 575527). Note the Sionics suppressor, the heavy barrel, and the modified (hooded) front sight and gas block.
Colt photo by Ed Guinan

Rock Island Arsenal on 25 March". By November 1967, a full year after Col. Yount's trip to Vietnam and the initiation of the scope project, the new PMR reported that the full requirement had been met:

> Telescopic Sight Program: *USARV has acknowledged receipt of all sight items requested. The following items have been provided:*
>
> *364 - Colt's Realist telescopes (for M16A1 rifles)*
> *352 - M84 telescopes (for M16A1 and M14 rifles)*
> *425 - M1C mounts (for M14 rifle)*
> *425 - prototype bases (for M14 rifle)*
> *100 - modified Weaver bases and rings (for M16A1 rifle)*



258. The still-later Leatherwood ART-II scope (discussed in US Rifle M14) in ART quick-detach mount, on the Leatherwood M16 base.

The HEL and Sionics Noise and Flash Suppressors

259. The Human Engineering Laboratories (HEL) M4 noise suppressor, attached to an M16A1 rifle. The red label on the buttstock reads "CAUTION THIS IS NOT A SILENT WEAPON".

Coincidentally, Col. Yount's last weekly report as Project Manager Rifles in June 1967 also included the announcement that USARV had submitted an ENSURE requirement for a large quantity of "silencers" for mounting on the M16A1 rifle, of a type developed by the Army's Human Engineering Laboratories [HEL] at Aberdeen Proving Ground.

As further discussed *US Rifle M14*, the HEL and the later Sionics devices were not true silencers but "noise and flash suppressors". As such, they were not designed or intended to actually "silence" a weapon, but only to confuse or deceive the enemy in his attempt to locate the firer of a shot by sound or muzzle flash. The HEL device and the theory behind it were described as follows:

Human Engineering Laboratories

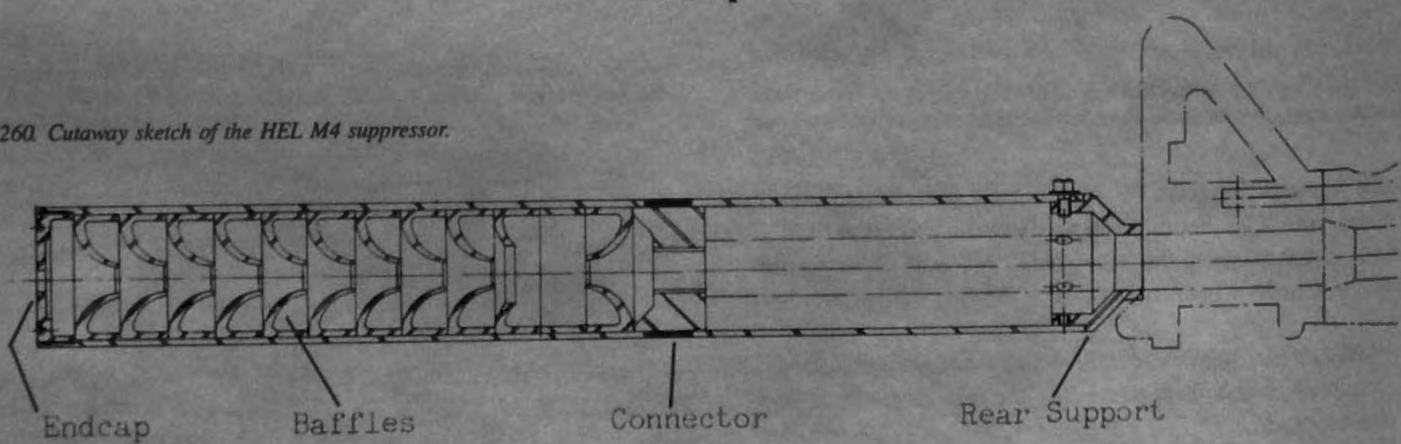
Interim Operation and Maintenance Manual

Noise Suppressor Assembly, HEL M4

For Use with Rifle, 5.56mm M16A1

Description

260. Cutaway sketch of the HEL M4 suppressor.



The noise suppressor assembly, HEL M4..consists of a steel cylinder and separate rear support with three mounting screws. The entire assembly is 12 inches long and weighs 1.8 pounds. A phosphate coating on all exposed parts gives protection from rust. The suppressor has no moving parts and, once installed on the M16A1, becomes a permanent part of the weapon and should not be removed. If not abused, the suppressor should last the lifetime of the rifle.

Purpose

The M4 suppressor is a device designed to deceive persons forward of the firer as to the true location of the firer.

Use of the Suppressor

The M4 noise suppressor is designed to be used only on a specially modified M16A1 [modification described below]. No attempt should be made to adapt the M4 suppressor to any other weapon or to attach it to an unmodified M16A1 rifle.

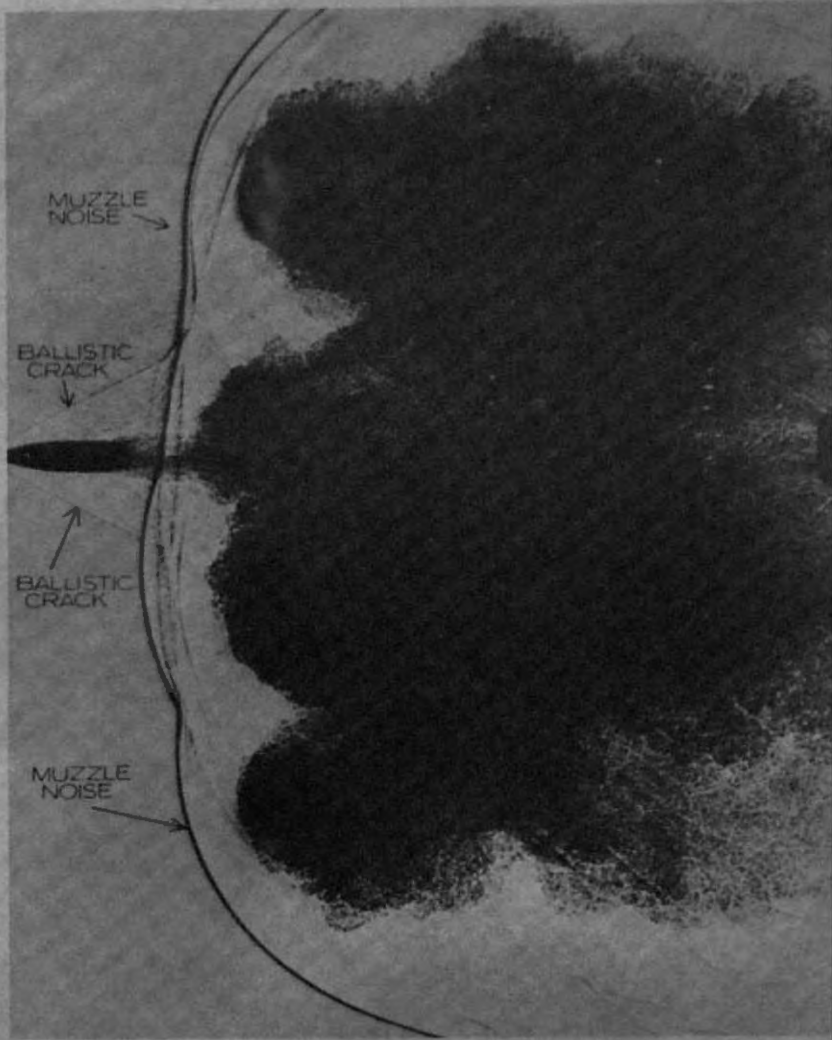
Use of Other Attachments

The XM3 bipod assembly may be used..in the normal manner when the M4..has been properly installed.

The M7 bayonet knife cannot be used with the M4.. suppressor.

Supply

No components of the M4 suppressor assembly or modified parts of the M16A1 rifle are available through normal supply channels and none are intended to be supplied as spare parts in the field. Initially a number of additional gas deflectors have been furnished to using units.



261. Fig. 3 from the HEL manual on the M4 suppressor, captioned "Actual Photograph of Rifle Firing".

Causes of Noise

When the M16A1 rifle is fired, the noise which can be heard actually comes from two distinct sources. Both occur so close together in time that the resulting sounds are often heard together as one noise. The two sources may be called muzzle noise and ballistic crack..

Muzzle noise is heard when the gases, produced by the burning of the propellant, reach the end of the muzzle. These gases, under extremely high pressure in the barrel, break out into the atmosphere behind the bullet.

Ballistic crack is caused by the supersonic speed of the bullet. Just as a jet plane breaking the sound barrier creates a "sonic boom", so the 5.56mm bullet driven faster than the speed of sound causes its own much smaller "sonic boom".

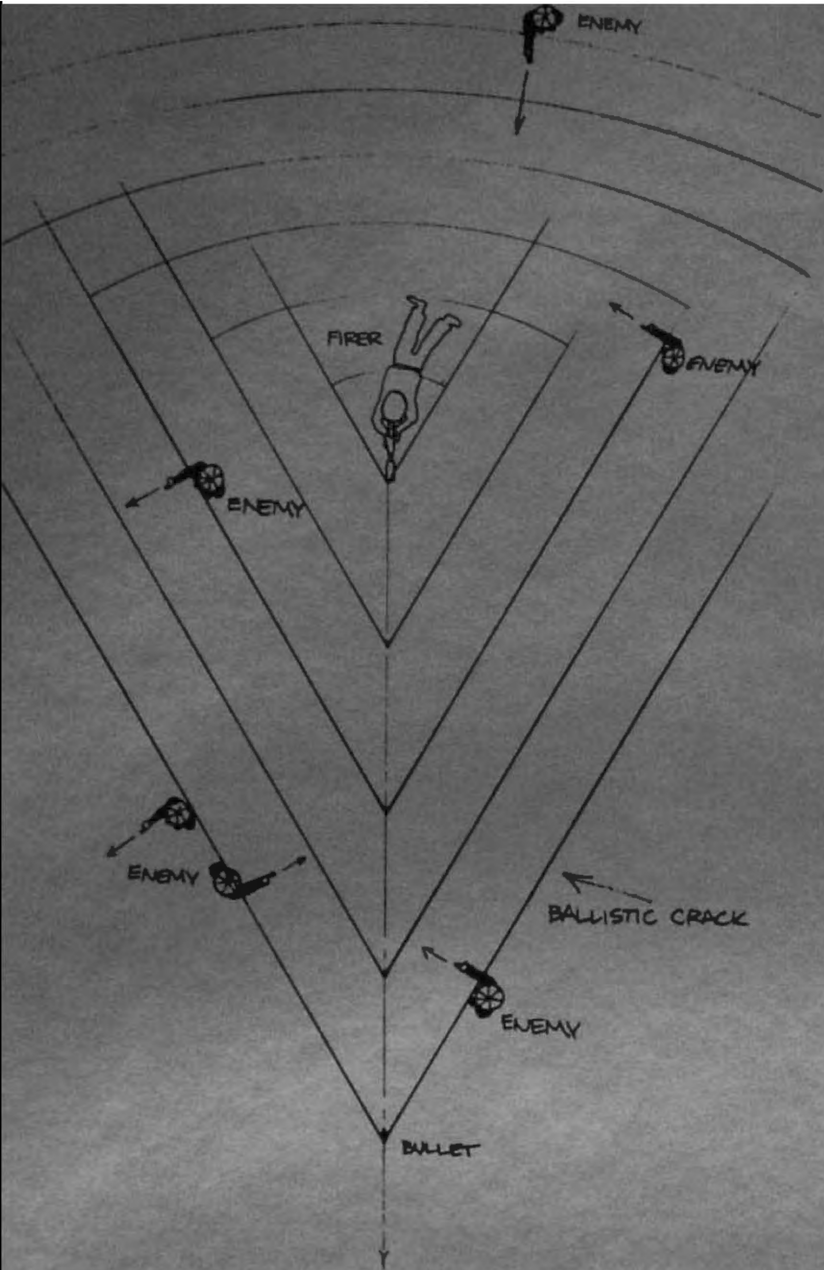
Action of the M4 Noise Suppressor

The M4..suppressor is effective only in reducing muzzle noise, since it does not affect the supersonic speed of the projectile.

The M4..reduces muzzle noise by containing within the suppressor the gases which cause the noise and allowing them to enter the atmosphere at a slower rate than usual.

The large black cloud and pressure front shown in figure 261 are not produced.

The M16A1 equipped with the M4..is not a silent weapon. The operation of the rifle and the ballistic crack are clearly audible.



262. Fig. 4 from the HEL manual: "People Tend to Locate a Sound Source Perpendicular to the Sound Wave They Hear".

Use of the M4 Noise Suppressor for Deception

Human beings determine the source of any noise by a sound locating process using both ears. Whether we are able to locate any sound depends in part on the loudness and duration of the sound and how attentive we are during that duration. In locating the source of hostile fire, most soldiers are alerted by the ballistic crack and locate the source by the subsequent muzzle noise (in a similar manner to the "Crack and Thump" technique taught in the US Army).

However, with the M4..suppressor installed, the muzzle noise or "thump" is not heard. Persons who try to locate the position of the firer from the ballistic crack alone usually choose a direction perpendicular to the sound wave they hear. Therefore, as shown in figure 262, persons forward of the firer will either be confused as to the firer's location or they will locate it incorrectly. Persons to the rear of the firer's positon should be able to locate it accurately.

Effects of Firing

..Muzzle velocity and cyclic rate are approximately the same, although recoil is much less with the M4 suppressor.

First Round Muzzle Flash

With the M4 suppressor-equipped M16A1 rifle, muzzle flash will occur any time there is oxygen in the suppressor. The flash is comparable to that from any standard M16A1 and consists of burning particles of carbon and propellant, some of which may be large enough to emerge as sparklers.

An M16A1 rifle equipped with M4 noise suppressor which has not been fired for 10 minutes can be expected to exhibit the muzzle flash described above for the first round. Some of the gases..will remain within the compartments of the..suppressor for about 10 minutes. These are inert gases which will not support combustion and, since they have dispelled the oxygen which was in the suppressor, each successive round will not flash.

Checking the Modifications

Bolt carrier: To handle the higher gas pressures within the weapon and to maintain the proper cyclic rate, a gas pressure relief port has been added to the bolt carrier (figure 263). The modified bolt carrier is intended only *for use with the M4 noise suppressor. If the modified bolt carrier is assembled into a standard M16A1 rifle, the weapon will not function automatically.*

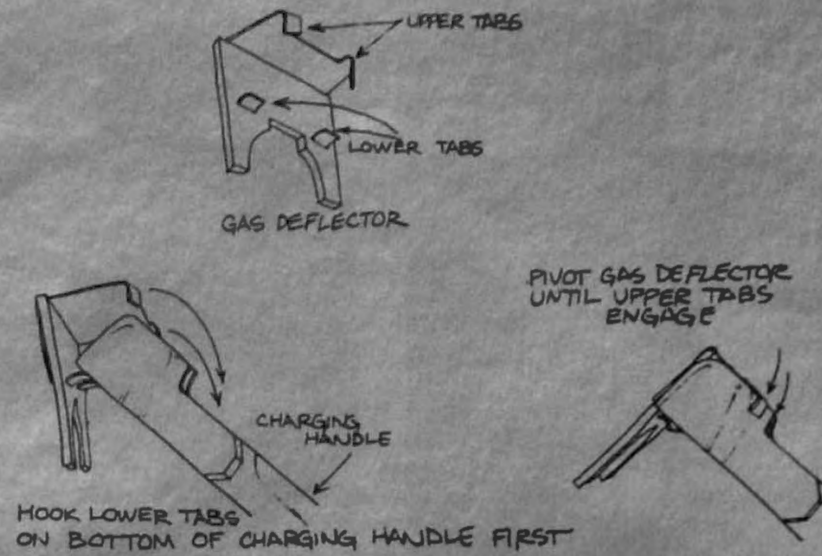
Gas deflector: To deflect escaping gases from the firer's eye, a gas deflector is clip-mounted onto the charging handle of the rifle (figure 264). The deflector does not interfere with the operation of the charging handle.

Col. Alvin C. Isaacs had succeeded the acting PMR, Lt. Col. Engle, in September 1967. In December, Col. Isaacs reported on the status of the suppressor project as follows:

Noise Suppressor HEL M4 (ENSURE #77)

The first production quantity of 120 suppressors has been completed. The planned production of 100 per week until the total 1,080 requirement has been suspended pending an evaluation of the 120 by USARV. HEL has formed a New Equipment Introductory Team and will depart for Vietnam on 3 January 1968..

263. Standard (above) and modified (below) M16A1 rifle bolt assemblies, showing necessary "gas pressure relief port" in the bolt carrier used with HEL M4 suppressor, in order to "handle the higher gas pressures within the weapon." The HEL manual states that the dedicated bolt "is intended only for use with the M4...If the modified bolt is assembled into a standard M16A1 rifle, the weapon will not function automatically".



264. The HEL M4 gas deflector, necessary "To deflect escaping gases from the firer's eye".
Above: method of clip-mounting the gas deflector onto the charging handle.
Below: the gas deflector installed.

The report of an Infantry Board trial in April 1968 spoke of chronic double-feeding and other malfunctions when firing with M4-equipped M16A1s, although it was admitted that the functional history of the weapons prior to installation of the suppressors was unknown.

In any event, Col. Isaacs announced in June that there were two new entrants in the running:

Noise Suppressor Requirement (ENSURE #77)

Two (2) new silencer devices have been introduced for testing. One from Sionics, Inc., Atlanta, Georgia (Noise and Flash Assembly MAW-A1) and a newly developed device by Frankford Arsenal will be tested in addition to the present HEL M4 device. This is a comparative test at Fort Benning, to be conducted during 17 June through 19 July 1968...The Project Manager has requested TECOM to expedite this test as rapidly as possible...The device for introduction into USARV for their evaluation will be selected immediately thereafter.

The Sionics (*S*tudies *i*n *O*perational *N*egation of *I*nsurgency and *C*ounter-*S*ubversion) device was much the same in appearance as the HEL M4, but significantly required no modification to the rifle, other than the usual removal of the rifle's flash suppressor before installation. The Sionics MAW-A1 and its design philosophy were described in the following unsolicited proposal:

265. Right side view of a Colt M16 rifle fitted with the MAW-A1, the 5.56mm version of the Sionics noise and flash suppressor, and the Colt/Realist 3x telescope sight. Note the remains of the milled-off bolt closure device housing on the rifle's receiver. This rifle was probably made during the "standoff" over the ball powder/cyclic rate problem (chapter 12), wherein the Army refused to accept XM16E1s averaging over 850 rpm on a 20-round burst. Until the issue was resolved, Colt's produced only M16s, which the Air Force would accept up to 900 rpm. *QAD (Ord) Pattern Room*

Sionics

Noise and Flash Suppressor Assembly MAW-A1

For Use With Rifle, 5.56mm M16A1

..No US Armed Service has ever employed gun or rifle noise suppressors except on extremely limited basis, usually for covert or clandestine operations. The need for such a device, however, has never been as great as exists today..

Combat operations in Vietnam have clearly shown that in counterinsurgency warfare the enemy must be denied every possible means of target acquisition. This is particularly true in nighttime perimeter defense and is simply a matter of life or death for long-range patrols, isolated units, and downed airmen.

To be completely effective a suppressor must reduce muzzle blast, or "thump", to an inaudible level within hand grenade range from the firing position. It must also eliminate or reduce muzzle flash to such an extent that it is invisible to the naked eye on the darkest night at a similar distance from the weapon..

A thorough analysis of prior art in the field of suppressor development combined with the original ideas of Mr. Mitchell L. WerBell, the company's chief of research and development, produced a new approach to..sound and flash suppression. Advice of the company's patent attorneys indicated that new and novel inventions had been achieved and applications for US Patent were filed under serial no. 700,239.

Intensive research and development on the M16A1 suppressor began in early 1967. Subsequently approximately 75 experimental models were fabricated and tested..

Characteristics of Sionics Suppressor MAW-A1

Weight is approximately 1 1/4 pounds employing 4130A annealed steel outer tube. This material will be designated for the first limited production units.

The MAW-A1 has a total length of 13 inches (tube 11 3/4 inches) and projects 9 inches beyond rifle muzzle, including muzzle threaded portion of the suppressor. Center of gravity of the loaded weapon is moved forward 2 1/2 inches..

Tests to destruction, or failure of the rifle barrel, indicate the proposed suppressor has a life at least equal to that of the M16A1 barrel.

The device is completely interchangeable on any standard unmodified M16A1 rifle without assembly adjustments for centering or alignment.

Assembly and disassembly each require approximately 15-20 seconds without special tools.

No gas shields are required on the rifle.

The cyclic rate of the weapon is not affected.

Accuracy of the weapon is not adversely affected and tight patterns are similar for the rifle both with and without suppressor installed.

Muzzle flash, after first shot, is invisible at considerably less than 30 meters down range on a dark night.

Muzzle noise or "thump" is inaudible at distances beyond 25-30 meters down range from gun muzzle.

It is not believed that any spare parts will be required due to wear; however, Teflon bushings (one per unit) can be lost in assembly or disassembly and plastic muzzle sealing caps, an accessory, will require resupply in the field if useage proves the need and usefulness of this item.

By early July, with the Fort Benning comparisons under way, one of the new Frankford devices which used porous aluminum as its sound-baffling medium exploded on automatic burst fire during the safety test, but the PMR noted that an alternate Frankford development, "utilizing the Maxim principle of noise suppression", was still in contention.

As for the MAW-A1, Fort Benning reported a problem with the early Teflon bushing:

..A plastic bushing component of the Sionics, Inc., device melted during safety test when the weapon temperature reached approximately 1,000 degrees. Sionics..has submitted a redesigned bushing of the same plastic material designed to ensure more complete gas obturation..

266. *Two views of the markings on the Sionics MAW-A1 suppressor.*

The firing portion of the Infantry Board trial with the HEL M4 and Sionics MAW-A1 suppressors took place at Fort Benning in August, under the expert guidance of then-Major Francis B. Conway, the Officer Commanding the MTU and the guiding hand behind the M21 sniper rifle program. The following are excerpts from Major Conway's report:

Accuracy Test of the M16 Rifle, With Special Devices

Objective

To determine if the noise suppressor device[s] affixed to the M16 rifle affects its inherent accuracy.

Scope

The test items have been undergoing extensive heat and reliability tests by the Infantry Board. Items were submitted for evaluation by Sionics of Atlanta, Georgia, the Human Engineering Laboratory and Frankford Arsenal.

Description of Materiel

1. *six each M16 rifles w/six each types of noise suppressors.*
2. *Bench rest w/sand bags (Parks Range).*
3. *"A" target centers.*
4. *3X Weaver scope..*

Conduct of Test

All groups were fired from the bench rest, rifle hand held on sand bags. Three each ten shot groups were fired from each of the six rifles with noise suppressor attached and then repeated with the normal flash suppressor, at 100 meters range.

The two rifles which showed the best accuracy at 100m were fired at 300 meters range with noise suppressor and with normal flash suppressor...Two each ten shot groups were fired... Three members of the Marksmanship Unit did the firing..

Findings

Rifle no. 1090045 was withdrawn from the test. This rifle could not be zeroed to remain on paper (24 inch square) at 100m with noise suppressor or flash suppressor.

Rifle no. 1091260 was the only rifle submitted for test that would fire less than a 4 inch extreme spread at 100m with the normal flash suppressor.

Rifle no. 822778 with [HEL M4] device and rifle no. 1094114 with [Sionics MAW-A1] showed a decided improvement of accuracy at 100m over that shown with flash suppressor.

Rifle no. 822778, with [HEL M4], showed a decrease of accuracy at 300 meters.

Rifle no. 1094114 with [Sionics] device showed a decided improvement of accuracy at 300 meters.

[The Sionics MAW-A1] was the only test device which improved the rifle's accuracy at both ranges fired..

The heat and reliability testing has caused excessive carbon buildup on the barrel and muzzle to the point where some suppressors are not aligned with the axis of the bore.

The inner tubes of the test devices are limited for bullet clearance due to carbon buildup..

Following the tests, with Sionics busily making more improvements to their MAW-A1, Col. Isaacs' office had gone ahead with the issue of a modified HEL suppressor called the M4A, which had been announced in mid-August:

Project: rifles [week of] 9-13 September 1968

Noise Suppressor (ENSURE #77): *The 100 [HEL M4A] noise suppressors shipped from APG 5 September 1968 have been received by USARV. Total on hand in USARV is now 120. USAHEL is proceeding on manufacture of remaining 960.*

The money came through the following month:

Noise Suppressor (ENSURE #77):

Funds totaling $42,673 were issued to procure 960 suppressors through HEL (Edgewood Arsenal). Delivery of the total quantity is scheduled for 31 December 1968. This office will proceed with the procurement plan in anticipation of favorable USARV evaluation..

The Project Manager's anticipatory actions were confirmed in November:

Noise Suppressors for M16A1 Rifle (ENSURE #77): *USARV has indicated acceptance of remaining quantity of 960 each [HEL M4A] suppressors...Results of test are that suppressors are satisfactory. Advantages include: Reduction of muzzle noise by fifty percent; reduction of enemy capability to pin-point a firer from the front; and significant reduction of muzzle flash . Disadvantages include: Suppressor causes weapon to heat up rapidly under full-auotmatic fire; additional weight of suppressor is a handicap when moving through swamp or heavy jungle; excess carbon*

builds up in barrel and firing chamber; with suppressor attached maintenance of the weapon is more difficult; some cases of foreign objects hitting the firer's eyes were reported; and the sonic crack generated by the bullet speed alerts an enemy even when muzzle noise is undetectable..

Despite the versatility and enhanced accuracy offered by the Sionics unit, not nearly as many were purchased. A "Bailment Agreement" was reached in 1969 which allowed the Army the use of 20 Sionics MAW-A1s on loan for extensive trial in Vietnam. In May of that year, Sionics' president Fred Brown explained some final improvements which had been made to the design:

After extensive tests at both Fort Benning and the Sionics Lab from July 1, 1968 to December 1, 1968, Sionics felt that several improvements were mandatory for the MAW-A1. The tests involving life expectance of the units as they were engineered at the time proved unsatisfactory to our expectations and as a result, Sionics decided to make major engineering improvements to the MAW-A1 so that it could withstand virtually any physical abuse imaginable, including overheating, gas erosion and to improve its efficiency..

..Reviewing the data from the destruct tests, Sionics deemed it mandatory to remove all internal aluminum parts and replace them with a more suitable material that was capable of withstanding the extreme heat and gas erosion that was encountered with sustained firing of the M16 in fully automatic mode.

This report went on to list the changes, which included a much higher reliance on 303 stainless steel, and a new bushing made from naval brass instead of Teflon. The heat of sustained firing had been found to destroy the temper of the pressure relief valve spring, even when made of special North American Rockwell temper-retaining Inconel, and the mechanical valve design itself was at length changed to one with no moving parts.

Mr. Brown rather dryly summed up the improvements to the MAW-A1, necessitated chiefly by the rigorous "fire to destruction" tests to which the Army had zealously subjected the Sionics suppressor, as follows:

..Even though there are only very rare occasions where a rifleman in the field would be able to stand the extreme heat of loading and firing 200 or more rounds fully automatic without interruption, Sionics feels that its present unit is capable of this type treatment. If the occasion should arise, we recommend only that the unit should be checked afterwards to make sure that all internal parts are tight.

Chapter Sixteen

THE HARD WAY ONE MORE TIME

The Ichord Report

Unaware of the history of Defense Department "direction", the October 1967 report of the Ichord investigation castigated Army and Defense officials in a series of 31 critical findings, which even the DOD's Defense Research & Engineering (DDR&E) rebuttal of February 1968 entitled *Appraisal of the M16 Rifle Program* summarized into fourteen "major areas" for comment. The DDR&E report was itself a product of the "intense review" which swept like a minor whirlwind through the Army's own house in the wake of the Ichord report.

The subcommittee members themselves had, during the course of the hearings, gone to Vietnam to interview troops and inspect the maintenance procedures and equipment actually being issued. They found, as had Col. Crossman, that both the Army and Marines were experiencing problems with their XM16E1 rifles, the most serious being the failure to extract. In this regard the subcommittee stated flatly that "the major contributor to malfunctions experienced in Vietnam was ammunition loaded with ball propellant". (To this the DDR&E *Appraisal* somewhat lamely riposted "When adequate attention was given to care and cleaning of the rifle, the malfunction rate dropped significantly, thus indicating that improper cleaning was a principal contributor.")

This only corroborated the subcommittee's next findings, which were that "proper care and cleaning are of the utmost importance", and yet "shortages of cleaning equipment, lack of proper training and instructions contributed to the excessive malfunction rate..", and therefore "various levels of command.. have been negligent in failing to provide..cleaning material and ..instructions." Further, on the issue of propellants, the change from IMR to ball powder was found to be "not justified or supported by test data", which as we have seen was true enough, as far as it went: interestingly, the reason suggested by the subcommittee for the adoption of ball powder in the first place had nothing to do with gunpowder *per se*:

> *..the sole-source position enjoyed by Olin Mathieson on ball propellants for many years and their close relationship with the Army may have influenced the decisionmakers..*

As for the rifle, the subcommittee found that "the AR-15/M16 rifle as initially developed was an excellent and reliable weapon", which "at the insistence of the Army" had been subjected to a number of modifications, certain of which were "unnecessary and unsupported by test data", while others "were made necessary only after ball propellant was adopted for 5.56mm ammunition."

Three modifications in particular were singled out; the first two, the bolt closure device and the chrome chamber, as having increased the unit cost of the rifle "substantially". (As mentioned the chrome chamber, expensive as it was, had belatedly been adopted on 26 May 1967 as the only sure way of reducing chamber corrosion and its attendant failures to extract, and was just barely being introduced at the time the Ichord report was written. Ironically, by the time new barrels were ready for issue, weapon maintenance had long since been accorded a high priority, and the extraction problems in Vietnam had virtually ceased). The third modification, the one-in-twelve rifling pitch, "decreased [the rifle's] performance characteristics". In general, "corrective action on deficiencies reported and product improvement of the weapon have been unnecessarily delayed".

To the members of the subcommittee, the most damning evidence of all concerned the use of IMR-loaded test ammunition while the preponderance of the cartridges in Vietnam were loaded with ball propellant:

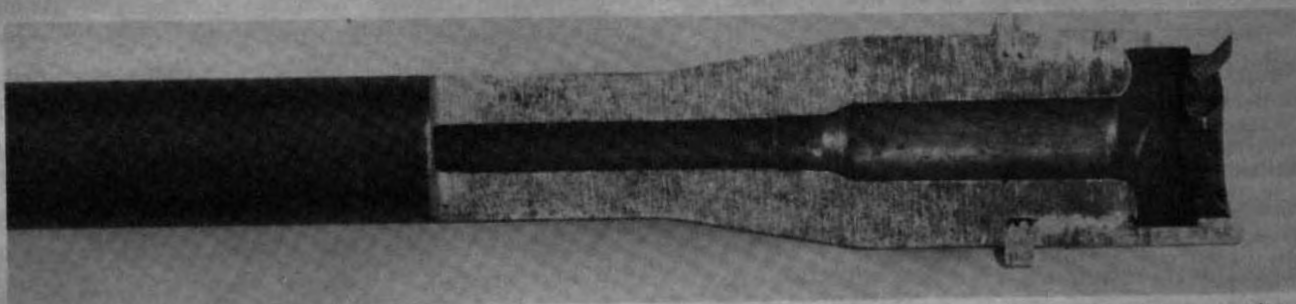
..That officials in the Department of the Army were aware of the adverse effect of ball propellant..as early as March 1964..yet continued to accept..thousands of rifles that were not subjected to acceptance or endurance tests using the ammunition of greatest density in the field..

..That the rifle project manager, the administrative contracting officer, the members of the Technical Coordinating Committee, and others as high in authority as the Assistant Secretary of Defense for Installations and Logistics knowingly accepted M16 rifles that would not pass the approved acceptance test..

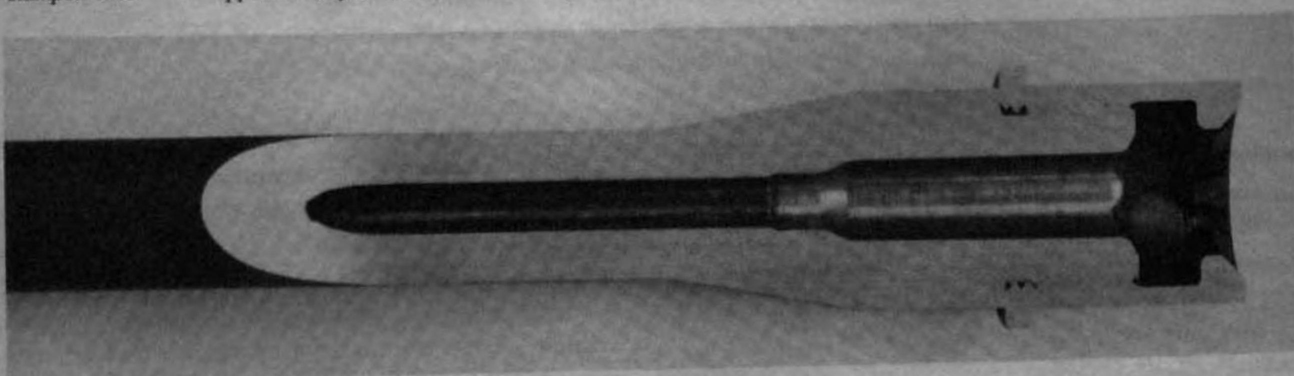
..That the failure on the part of..the Army to cause action to be taken to correct the deficiencies of the 5.56mm ammunition borders on criminal negligence.

The Ichord report went on to point an accusatory finger at a number of other facets of the program, such as the increased fouling produced by ball powder, and the fact that there was no guarantee that the modifications being introduced in an effort to reduce malfunctions in Vietnam, such as the new buffer and chrome chamber, would actually work.

One of the subcommittee's final recommendations (number 25) was that "a thorough review be undertaken of the Army's system of development, production, and introduction of a new weapon into the inventory" in order to determine if the M16 program was a typical example of how the Army operated, for, "The manner in which the Army rifle program has been managed is unbelievable. The existing command structure was either inadequate or inoperative. The division of responsibility makes it almost impossible to pinpoint responsibility when mistakes are made.." The allegations of criminal negligence and "unbelievable" program management went unanswered in the DDR&E *Appraisal*: paradoxically by this time the only alternative, the truth, would quite likely have been popularly interpreted as a further Army attempt to avoid its just desserts.



267. Above: sectioned plain steel barrel, showing chamber corrosion. Below: sectioned barrel with chrome chamber. Such barrels are identified by a stamped letter "C" approximately 1 7/8" from muzzle face. Attempts were made at Rock Island to develop a procedure to retrofit unserviceable barrels with the new chrome chamber, but this plan was later abandoned.



The Aftermath

Over the 1968 new year period, ironically just as the field malfunction problems finally started to fade away, the Army faced the full force of adverse popular opinion resulting from the un-pulled punches of the Ichord report. While the Army had weathered rougher storms, the gravity of the situation seemed evident in the Army's quick and thorough compliance with the subcommittee's call for a complete review of the rifle program:

Department of the Army

Office of the Chief of Staff

November 8 1967

Memorandum for:

Deputy Chief of Staff for Personnel
Deputy Chief of Staff for Logistics
Comptroller of the Army
Chief of Research and Development
Assistant Chief of Staff for Force Development
The Inspector General
Chief of Information
Chief of Military History
Chief, US Army Audit Agency

Subject: The M16 Rifle Program

The Chief of Staff has directed an intensive review of Army management practices related to the evaluation and adoption of product improvement modifications to the M16A1 rifle/ammunition system. The review will determine whether there are general deficiencies in the Army's management of the small arms program...The principle subject areas of inquiry are:

The product improvement modifications..and the justification therefor.

The effects of fouling..

The development of propellants..with emphasis on the functioning of the M16A1..

The adequacy of test procedures to detect the occurrence and the persistence of problem areas..

The adequacy of regulations and policy on directive statements..

The scope and adequacy of the Army training program.. with particular emphasis on individual maintenance training..

The adequacy of the organizational structure..

The procurement history of the AR-15/XM16E1/M16A1 weapon system..

The Case Hardness Problem

The Chief of the Technical Evaluation Branch of AMC's RRD&E Directorate was still none other than the erstwhile "father of the M14", Dr. Frederick H. Carten, who, as we have seen, had been deliberately excluded from the decision-making process in the M16 program, ironically due to OSD disfavor over the way Ordnance had handled the procurement of the M14.

Nevertheless, as one of those ordered to respond to the Chief of Staff's "intense review", Dr. Carten certainly came in for his share of last laughs.

..It was not until October 1964 that Frankford Arsenal identified case hardness as a significant factor in AR-15 weapon functioning. Frankford recommended procedures for establishing case hardness patterns. The Project Manager

Dr. Carten's 1970 report to the Blue Ribbon Defense Panel, itself one of the series of "shake-ups" which reverberated through the defense establishment in the wake of the Ichord report, was entitled *The M16 Rifle - A Case History.* In his eagerness to be heard at last, and with the benefit of hindsight, Dr. Carten's *Case History* consisted largely of scathing but not entirely fair criticisms. For example, cartridge case hardness was mentioned earlier as a parameter that had heretofore been virtually ignored: lately everyone had been far too busy trying to figure out just what was really behind the baffling failures to extract in Vietnam. Dr. Carten felt that there was a connection:

stated that in the absence of malfunction reports [and, as we have seen, securely under the heel of the OSD's Gilpatrick directive], there was no need to establish hardness pattern control. In 1966 with new ammunition producers coming

into the picture, the Project Manager recognized the need for controls, and in September 1966 Frankford began an intensive study to develop the required data. Field complaints on case extraction difficulties resulted in a firm decision to establish case hardness controls in August 1967 with the manufacturers being given six months to adjust their production lines.

This laxity in quality control of cartridge case production undoubtedly contributed to weapon-system malfunctions in the field.

The Gas Tube Fouling Problem

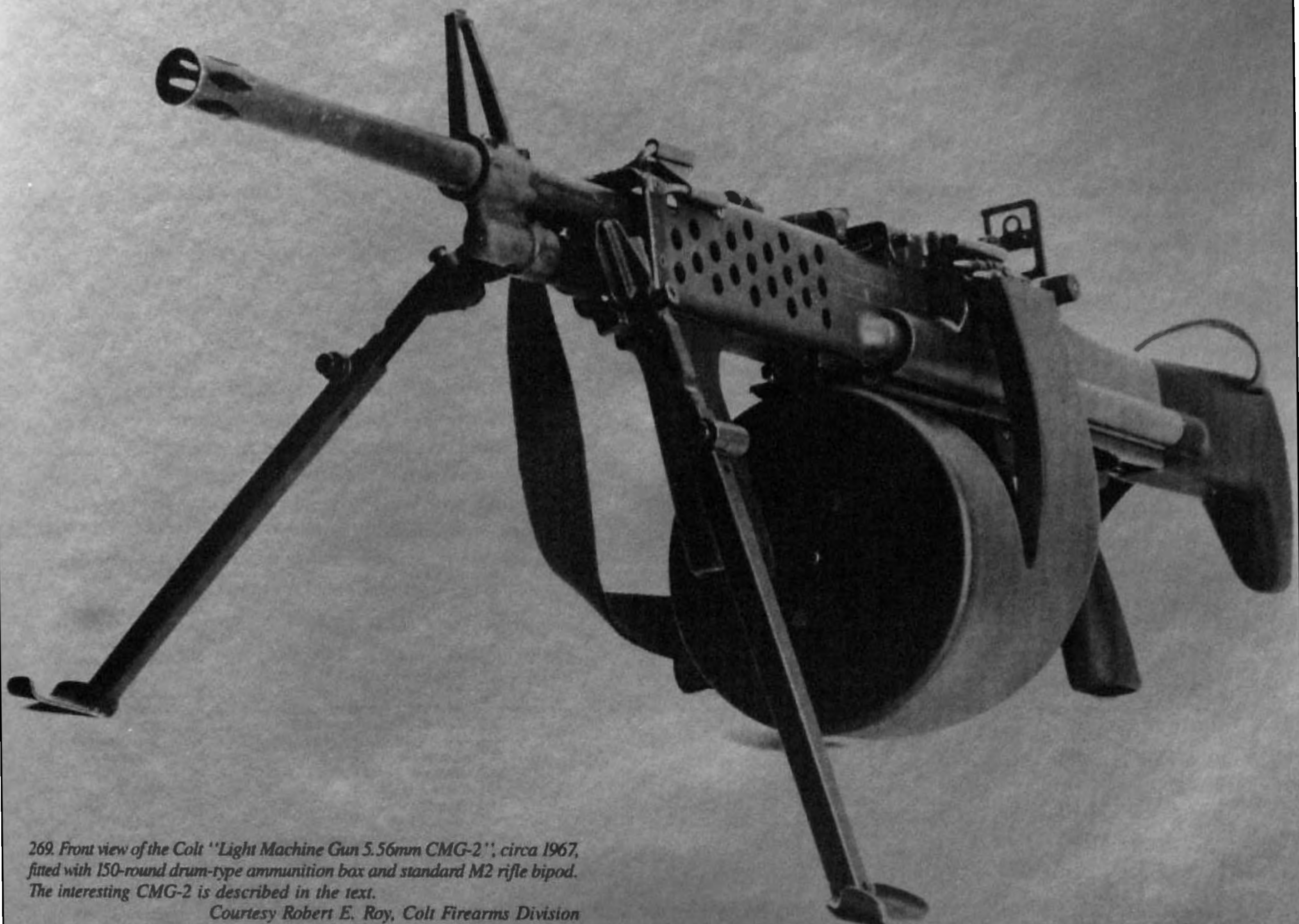
It was by this time well known that ball powder produced more visible fouling than did IMR, but as yet no real link had been established between the fouling and any malfunction problems in the field, provided of course that the weapons were kept properly cleaned.

Warming to his task, Dr. Carten recalled a chilly incident which had occurred in the fall of 1967. During a routine 6,000-round endurance/acceptance test at Colt's, a rifle "became sluggish and ceased firing" due to a buildup of fouling products in the M16's Achilles' heel, the long, "uncleanable" gas tube. This had not occurred in any previous endurance testing with ball powder, and a careful examination concluded that there was a very unusually high percentage of calcium carbonate in the particular lot of WC846 which had been used in the test. A two-year series of test firings at Frankford Arsenal corroborated the fact that production lots of ball propellant rarely approached the maximum allowable 1.0% calcium carbonate content, and that the relatively high percentage in the test lot was indeed an isolated case. In any event, on September 29 1969 the allowable maximum calcium carbonate content in ball powder was reduced to 0.25%.

Even though no credible evidence was ever presented to link calcium carbonate with the failures experienced in the field, in 1967 this disturbing news had further fuelled the fires of debate over the increasingly confusing issue of powder for 5.56mm cartridges.

The Colt "Light Machine Gun 5.56mm CMG-2"

268. The Colt CMG-2, partially stripped. Note the detachable barrel and the Johnson/Stoner bolt, mounted in a sturdy BAR-like gas piston which rides on an AR-18-type double guide rod/operating spring assembly. The CMG-2 had no cocking handle per se; the operator simply unlatched the pistol grip ("fire control group") by means of its latch lever and thrust it first forward, (latching the sear into the rear of the gas piston/bolt carrier assembly) and then back, repositioning the pistol grip for firing and leaving the bolt assembly cocked on the sear.

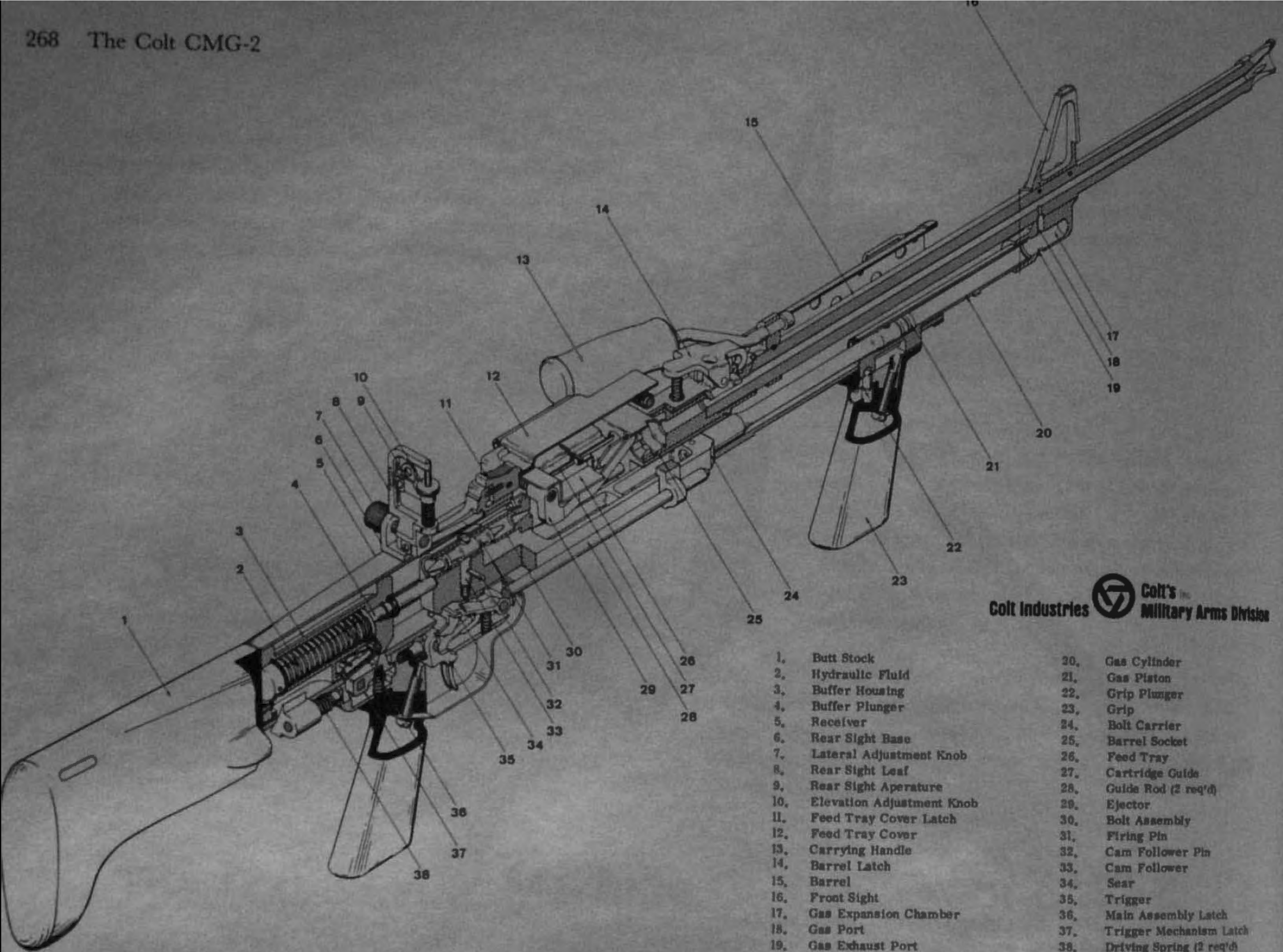


269. Front view of the Colt "Light Machine Gun 5.56mm CMG-2", circa 1967, fitted with 150-round drum-type ammunition box and standard M2 rifle bipod. The interesting CMG-2 is described in the text.
Courtesy Robert E. Roy, Colt Firearms Division

Recognizing the need for a versatile light machine gun to provide increased fire support for combat units in the field, during the period 1967-1969 Colt's Military Arms Division introduced a successor to the short-lived CMG-1, the equally short-lived CMG-2, which in their words combined "the most practical trade-off of design parameters to obtain the required durability and sustainability of operation".

Feeding ammunition linked in standard M13 links from a 150-shot drum, and supported by a standard M14-type M2 bipod, the CMG-2 was designed to fire the extended-range Colt 68-grain GX-6235 bullet (discussed in chapter 22). In order to stabilize this heavier bullet the CMG-2's quick-change barrel was rifled with one turn in 8 7/8 inches. Several other interesting features of the CMG-2 were described in the Colt brochure. To begin with, the CMG-2 was cocked and charged by depressing the latch lever at the rear of the trigger housing and sliding the pistol grip or "fire control group" forward and then back. The extractor, always a potential source of trouble in any weapon design, was in the CMG-2 not a moving part at all but simply a machined groove in the face of the bolt. In addition, the CMG-2 featured a firing pin with a striker point at each end, which provided "foolproof assembly and extended service life".

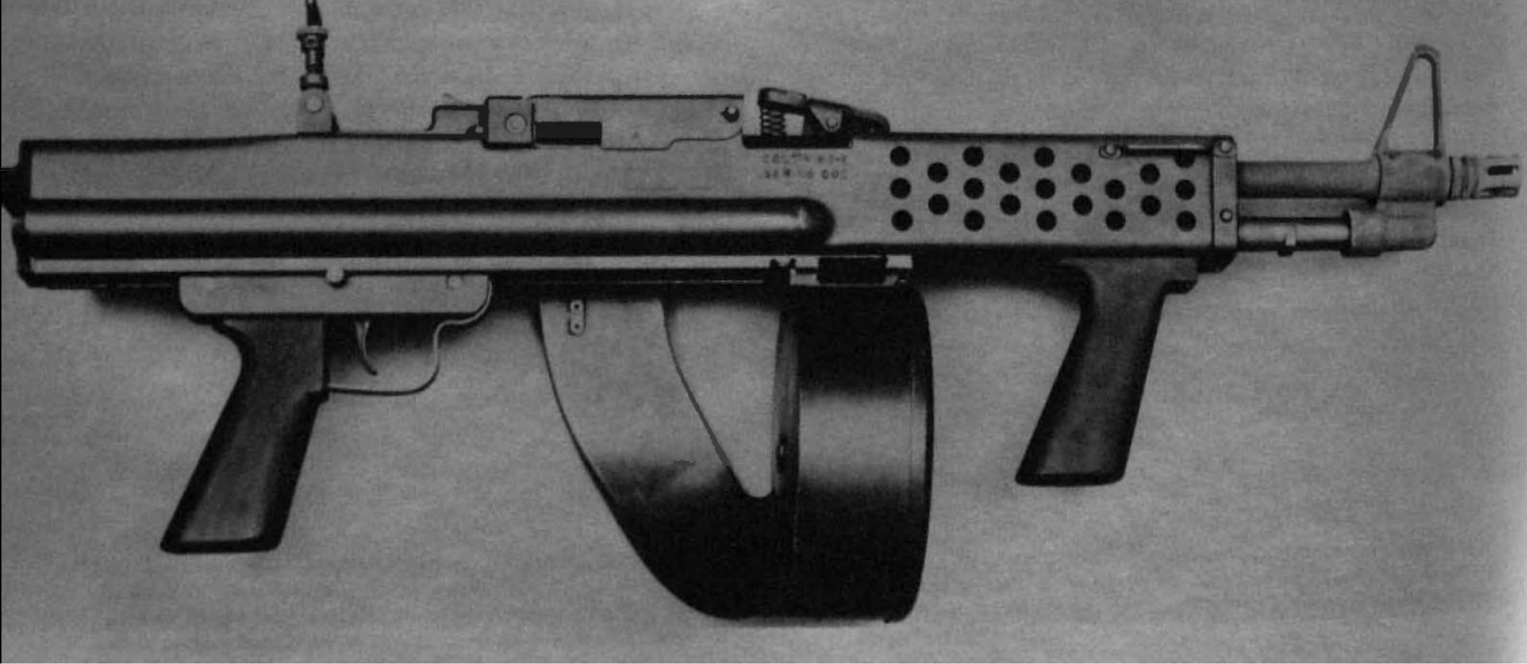
In spite of the novelty of the CMG-2, the design met with little success, and only prototype quantities were produced before the project was abandoned.



1.	Butt Stock	20.	Gas Cylinder
2.	Hydraulic Fluid	21.	Gas Piston
3.	Buffer Housing	22.	Grip Plunger
4.	Buffer Plunger	23.	Grip
5.	Receiver	24.	Bolt Carrier
6.	Rear Sight Base	25.	Barrel Socket
7.	Lateral Adjustment Knob	26.	Feed Tray
8.	Rear Sight Leaf	27.	Cartridge Guide
9.	Rear Sight Aperature	28.	Guide Rod (2 req'd)
10.	Elevation Adjustment Knob	29.	Ejector
11.	Feed Tray Cover Latch	30.	Bolt Assembly
12.	Feed Tray Cover	31.	Firing Pin
13.	Carrying Handle	32.	Cam Follower Pin
14.	Barrel Latch	33.	Cam Follower
15.	Barrel	34.	Sear
16.	Front Sight	35.	Trigger
17.	Gas Expansion Chamber	36.	Main Assembly Latch
18.	Gas Port	37.	Trigger Mechanism Latch
19.	Gas Exhaust Port	38.	Driving Spring (2 req'd)

270. A Colt factory cutaway drawing of the CMG-2, with parts list. Note the double-ended firing pin. The CMG-2 was demonstrated (to little avail) in the SAW trials and in Asia, around the time of the emergence of the Ultimax 100 (chapter 21).

271. Right side view of one of the very few prototypes ever built of a short-barreled "Assault Machine Gun" CMG-2, serial no. 003. Used in the US Navy SEAL team trials in the late 1960s which resulted in the adoption of the Stoner "MG MK23 MOD 0". Note the absence of a cocking handle slot in either side of the CMG-2's receiver (fig. 268).

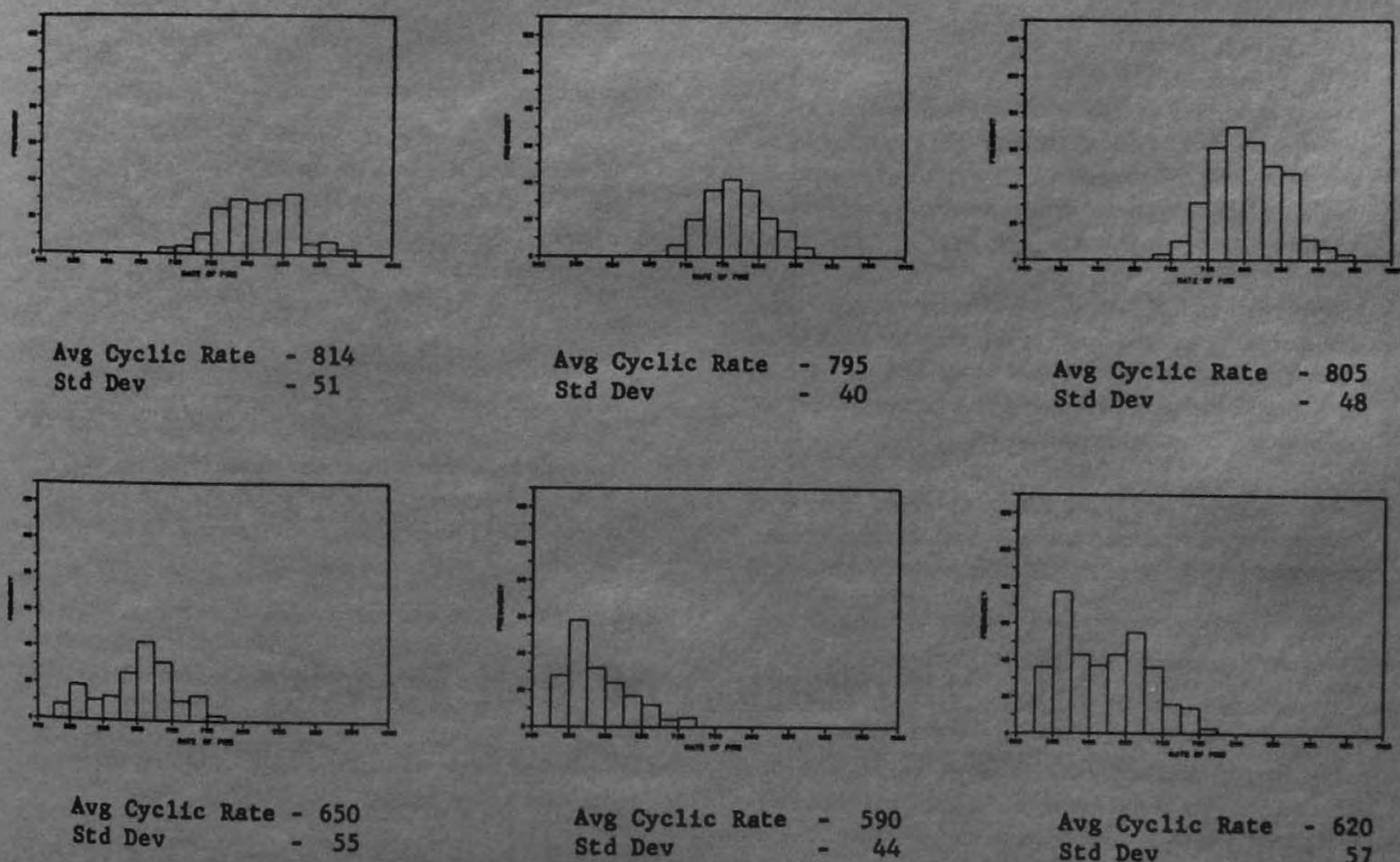


Olin Cops a Plea

Yet another reaction to the Ichord report had followed smartly on the heels of that document's release in October, 1967. Professedly stung to the quick by the subcommittee's "criticism of the choice of powder used" in 5.56mm cartridges, Olin's vice president and general manager of the Winchester/Western Division, W.L. Wallace, replied to the Ichord charges with an impassioned, two-page press release. Amid much historical background, concluding with the fact that Olin considered the ball powder process "an exemplary example of the working of the free enterprise system at its best", Mr. Wallace made it quite clear that Olin was willing to accept none of the responsibility for the use of ball powder in the M16:

> *..The standard WC846 powder for these [5.56mm] cartridges has met every government specification. All 5.56mm cartridges loaded by Olin have consistently met every established government specification. The powder and ammunition specifications were established by the Army, and their suitability for the M16 rifle can be determined and commented on only by the Army. As the [Ichord] report points out, [ball] powder was neither designed nor developed with this rifle in mind.*

> *The functioning of the M16 rifle depends on a gas system design which is entirely different from that of any other automatic weapon in the world. The several peculiar characteristics of this system might well call for unusual specifications of powder and cartridges. Olin has not been involved in the development of M16 cartridge specifications and so has no direct information on the subject..*



272. Fig. 5 from Frankford Arsenal's Ten Special Tests (chapter 19), a comparison between types of ammunition (ball; tracer; ball-and-IMR propellant) and rates of fire. Each of 12 rifles, all with chrome chambers, fired 600 rounds per day (six firing M193 ball and six firing M196 tracer) for 10 days under all test conditions.

Above, left to right: ball; tracer; ball-and-tracer. All cartridges loaded with WC846 (ball) propellant.
Below, left to right: ball; tracer; ball-and-tracer. All cartridges loaded with IMR 8208M propellant.

Olin's previous willingness to supply all the ball powder the Army would buy is a matter of record: the apparent reversal of this position prompted the following reply to Olin from Major General Frank G. White, the Commanding General of MUCOM, the Army Munitions Command at Dover, New Jersey:

Dear Mr. Wallace:

Thank you for your letter dated October 19, 1967 which forwarded a copy of your press release..on the M16 rifle and 5.56mm ammunition. A careful reading..has raised a question in our minds as to whether or not there has been a change in your corporation's position on the suitability of WC846 propellant for 5.56mm ammunition..

The following extracts illustrate the apparent change in your company's position:

a. Olin's 1964 position [from Olin's introductory letter, reprinted in chapter 9]: "We are proposing WC846 BALL POWDER.."

b. Olin's 1967 position [above]: "..might well call for unusual specifications.."

The final responsibility for determining the suitability of WC846 propellant for 5.56mm ammunition rests with the Army, as your press release noted. However, if Olin as the developer and manufacturer of WC846 propellant is no longer confident that this propellant "is entirely acceptable for the 5.56mm cartridge", then the Army must certainly give that fact the most careful consideration..

Olin's Mr. Wallace did an admirable job of avoiding the unmistakable horns of the dilemma he had just created, persisting:

Dear General White:

This is in reply to your letter of 14 November 1967, in which you asked for clarification of Olin's position on the suitability of WC846 propellant...We are pleased to respond.. and are of the opinion that there is no discrepancy between our two statements quoted in your letter.

We believe that WC846..meets and has met all of the existing specifications established by the Army for the 5.56mm cartridge...In fact, speaking now as loaders, we have yet to see any other powder which will consistently meet the existing specifications in production.

The question raised by [the Ichord] report and Olin's news release is whether or not the Army's cartridge specifications, as presently defined, provide a suitable match of the 5.56 cartridge and the M16, given the peculiar and special problems posed by the M16's novel gas system..

..It is our considered technical opinion that there are serious inherent weaknesses in the present M16 gas system which make the gun highly likely to malfunction in a number of types of field conditions, and which make functioning of the gun unusually susceptible to otherwise insignificant variations in powder, priming and loading..

..it is now evident that there may be some special problems in the M16 connected with dumping spent powder gas over the incoming cartridges before they enter the chamber. We have not been able to make any visible improvement in the burning characteristics of WC846 in the M16, and it is a fact that Ball Powder characteristically yields a higher level of unburned solids than IMR..

The Vindication of Ball Powder

The surprising upshot of this exchange was complete capitulation on the part of the Army in the face of the determined Olin attack, which it must be admitted did have reason on its side. As recorded in the PMR's 13-17 November 1967 significant action report,

..It was agreed and endorsed by General White that no defensible technical reason now exists for favoring IMR over ball propellant. It was agreed that preferential shipment of IMR to Vietnam implies a superiority which in turn infers that IMR should be used exclusively. This cannot now be supported against those who might challenge it.

At this point, in a 25 November reply to an earlier situation report from General Besson, the Chief of Staff General Johnson himself intervened with a Solomon-like decision:

..The loading of 5.56mm ammunition with both IMR 8208M and WC846 propellants is approved until such time as testing conclusively proves or disproves that WC846..is a cause of the malfunctions.

Any recommendation to reduce the nominal velocity requirement for M193 cartridges by 50 feet per second must be supported by detailed documentation and testing data..

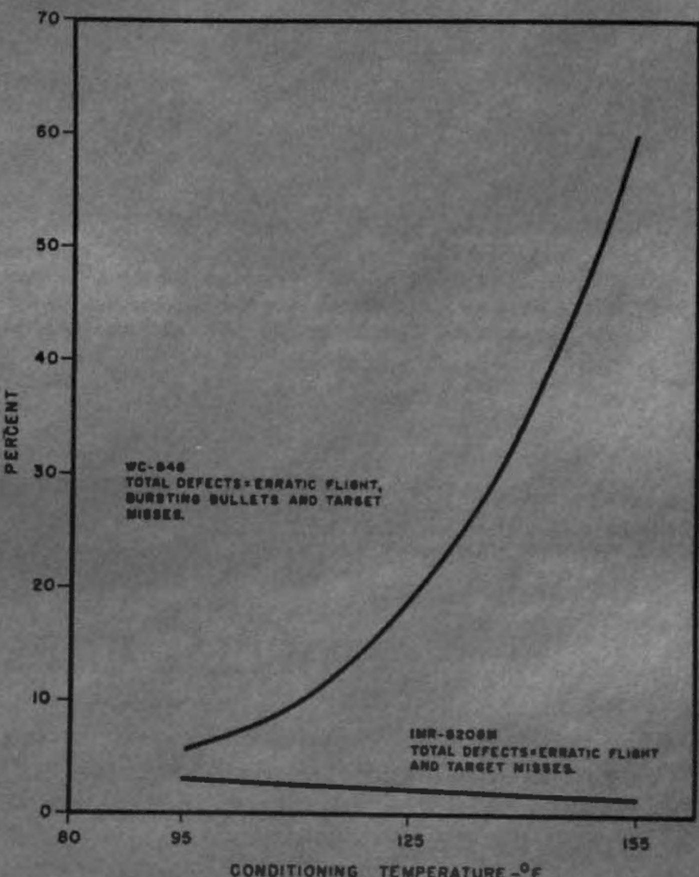
DuPont's Third Try - IMR 8208M Comes on Stream

8208M was the new name for DuPont's EX8208-4, already described in Frankford's *Investigation of Alternate Propellants* report (chapter 11). Unfortunately, in the new "climate" of the M16A1, where everything possible had been done to accommodate the idiosyncracies of Olin's ball powder, 8208M faced a decidedly checkered career.

Everything began well enough, it seemed, with an exclusive contract to load M196 tracer ammunition with 8208M propellant. This situation was due, ironically, to severe problems which had been encountered with ball-powder-loaded tracers. "Surging", or the erratic cyclic rate of a mixed ball-tracer magazine, was relatively minor, but heavy barrel coppering had also been reported. This phenomenon resulted in many more unserviceable barrels than expected and, especially in the short-barreled XM177E2, quickly reduced the bore diameter to the point where the hollow-based and therefore more vulnerable tracer jackets simply disintegrated, with consequent keyholing and abrupt degradation of accuracy and power:

Project:
rifles [week of] 4-8 December 1967

Cartridge Tracer M196, 5.56mm: *Propellant WC846 is no longer authorized for loading cartridge tracer M196..and is being deleted from the TDP. [Frankford] has requested APSA to discontinue loading of any tracer rounds at [Lake City and Twin Cities]. Shipments of M196 tracer in support of SEA are restricted to those lots which contain IMR propellant.*



273. Fig. 1 from Frankford's Ten Tests report, showing total defective flight vs. temperature for different (ball and IMR propellant) loadings of the M196 tracer cartridge. In the trial, 5 lots of WC846 and one lot of IMR 8208M, were fired from six new M16A1s which had been heat-conditioned for six hours at 155°F, at paper targets at 25 meters range.

Some Experimental M16 Gas System Modifications

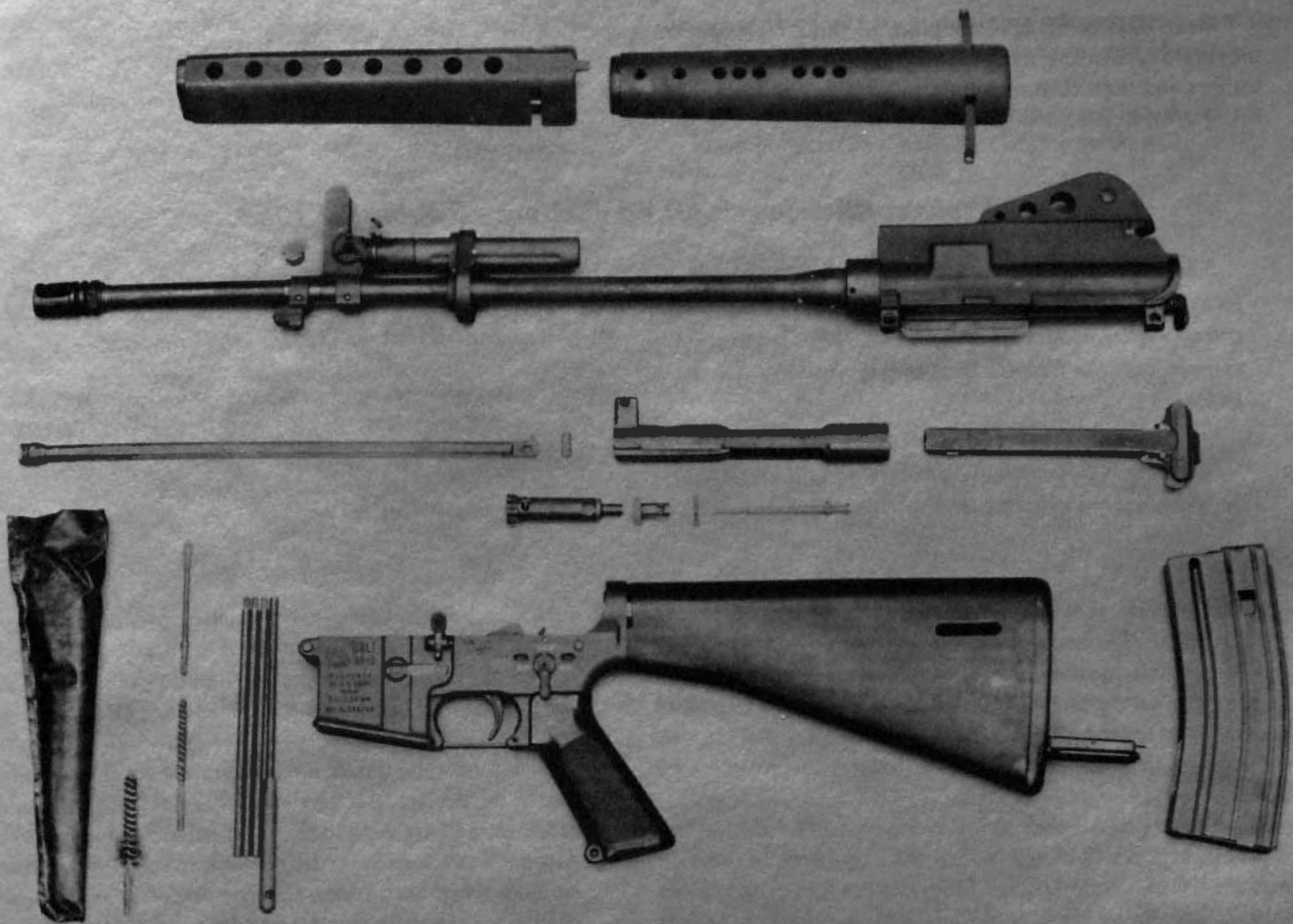
Another interesting offshoot of the ball/IMR controversy was a series of short-lived investigations at Colt's, Rock Island, and coincidentally Olin's Winchester/Western Division, to develop a new gas system for the M16. Olin's contract was to modify and test 25 new M16A1s with their design of top-mounted, standard-type gas impingement system.

The PMR reported in May 1968 that in-house testing of the modified gas system at Winchester had been completed: "The limited Winchester tests indicate that the modified rifles performed about equally to the current M16 rifles used as control weapons. Ten (10) prototype rifles with the modified gas system have been shipped to RIA for government tests."

The Colt Model 703

274. The first prototype of Colt's gas piston-operated "model 703", built from a new upper receiver and gas piston system on a standard M16A1 lower receiver. Shown ready to fire in the sling-mounted, waist-level position. Note the full-curved 30-round magazine. (Compare with fig. 275: visible changes in the later model center on the front sight/gas block). Colt's originally introduced this version to the Army as the "M16A2", a term which, along with the Colt-designated "700 series" model nos., was later reserved for a more auspicious purpose (chapter 23). Colt photo by Ed Guinan

275. Left and right side views of a later prototype Colt model 703. Note (above) the adjustable, three-position gas regulator, much like that of the Stoner XM22E1 (fig. 194); the redesigned handguards; the 4-position burst selector; and the through-the-butt sling slot. Colt photo by Ed Guinan



276. The Colt model 703, partially stripped. Note the (quick-detachable) snap-clips on the upper handguard; the gas piston, particularly its interface with the bolt carrier (the vertical projection extends upward to contact the charging handle); and the butt trap in the stock for stowage of cleaning equipment.

Turning the Tables in Panama

Meanwhile, in response to the Ichord subcommittee's call for a thorough and objective weapons test by an independent organization, another exhaustive trial of the M16A1's "operational reliability" had been ordered. On 13 November 1967, the Defense Department's Weapons Systems Evaluation Group (WSEG) was assigned as Executive Agent in charge of this major effort. WSEG was responsible for the preparation of the test plan, the overall direction and conduct of the trials themselves, and the subsequent preparation of a final report.

The WSEG tests were rather secretive, but it is clear that they were elaborately designed, with the assistance of the independent, non-profit Army-funded Institute for Defense Analyses (IDA), to simulate conditions of jungle combat. IDA was one of the many government-sponsored "think tanks" which followed the demise of the Johns Hopkins-based Operations Research Office (ORO).

Fort Sherman, in the Panama Canal Zone, was chosen as having environmental conditions most closely approximating those in Vietnam. As Dr. Carten pointed out, this represented virtually the first time that specific consideration had been given to Vietnam's tropical environment in the entire history of the M16 program:

> *..No tests, other than the SAWS troop tests and limited user evaluation in 1962, have been conducted by the U.S. Army Tropic Test Center. On the other hand since production began in March 1964, the M16 has been used in combat exclusively in a tropic environment..*

Fifteen days of firings took place in January 1968, employing 522 Marine troops using M16A1 rifles with new buffers and both chromed and unchromed chambers, and firing ammunition loaded with both ball and IMR propellant. The M14 was fired as a control weapon.

Remington's new IMR8208-loaded ammuniton was not favorably received:

Project: rifles [week of] 29 January - 2 February 1968

5.56mm Ammunition*: Based on preliminary information from the Marine Corps test in Panama, indicating higher malfunction rates for IMR-loaded ball ammunition, the Defense Department..has directed the following:*

- Loading of 5.56mm ball cartridges with IMR8208 will be immediately suspended until further notice.

- All shipments of 5.56mm ball cartridges loaded with IMR propellant to overseas adressees will be stopped and suspended for use in CONUS except for training.

- Determine those lot numbers of ammunition loaded with IMR propellant; furnish these lot numbers to USARV immediately.

The above does not apply to tracer ammunition..

The final report of the Panama trials, *WSEG Report 124* dated February 1968, concluded that the M16A1 with ball propellant was more reliable than the same weapon firing IMR powder. The M16A1s "approached but did not equal" the reliability of the M14 control rifles. The M16A1s equipped with chrome chambers gave, as expected, fewer failures to extract.

WSEG's Panama trials proved beyond a doubt that reliability problems in new-buffered M16A1 rifles could not be ascribed to the use of ball propellant. This outcome had evidently not been foreseen by Defense officials, with the result that while the M16A1 was declared acceptable for combat, the test report itself was promptly classified and exempted by OSD ruling from the normal provisions for automatic downgrading of classification. It is ironic that the most significant investigation of the "ball powder problem", itself perhaps the only really constructive result of the Ichord hearings, has never been made public.

With the results kept secret, the only real measurable upshot of the Panama trials was that the Army was once again in a sole-source position on propellant, ironically not with one but *two* sole sources: one for M193 ball, and one for M196 tracer.

By this time the situation was stabilizing under fresh leadership in the Project Manager's Office. With the establishment of full-time PMR liason offices in Vietnam and at Frankford Arsenal, introduction of the new buffer and better cleaning equipment and instructions, and the introduction of the chrome chamber and more uniform cartridge case hardness specifications, rifle maintenance problems in Vietnam ceased to be an issue. In sum, it appears that the "no-holds-barred" Ichord investigation yielded little other than some biased, not to say rabid, anti-Army publicity and its consequent effects upon the respective professional careers of some of the protagonists.

Vietnam in Retrospect

Who better, perhaps, to place the XM16E1's record in Vietnam in a proper perspective than retired Brigadier General S. L. A. Marshall, whose hard-hitting "combat critiques" on the Korean war were, as we have seen, a foundation-stone of the entire light rifle program. General Marshall had been quoted on the subject of the M16 rifle, somewhat out of context perhaps, from a newspaper article as part of Colt's submission to the Ichord subcommittee:

..There is no other rifle available to the fighting line of the US that will serve the present purpose more adequately. On that point there should be no doubt whatever. It is not a perfect rifle. There is none such, and try as we will, we will not find one in the future. That point aside, the M16 is better suited to the conditions under which our infantry must fight in Vietnam than the M1 rifle or the Carbine of the Second World War and Korea would be, and the M16 is generally more adaptable to the tactical problem than today's M14.

The sheer *practicalities* of the issue therefore, decreed the M16. But what of the malfunctions? Perhaps here too were reasons to look askance at the unprecedented presence of the media in Vietnam, for, according to General Marshall:

> *..Though blocks and stoppages occur there have been only two operations in which the percentages of such failures warranted the raise of eyebrows. In the worst instance the record was still better than with the Carbine in Korea.*

END OF PART II

PART III — WARP SPEED AT LAST

Chapter Seventeen

THE GREAT RIGHTS ISSUE - THE "POLITICS OF PROCUREMENT"

Introduction

Meetings between David Scott, then the president of Colt's, and Kendall Barnes, General Counsel for the Army Materiel Command, had first begun within two weeks of the formation of the Project Manager's Office back in March 1963. The meetings were to discuss "patent rights and licensing agreements in association with the AR-15 rifle program". Apparently some informal talks had already been held on the subject, which had led the Deputy Commanding General of Army Weapons Command, Roland B. Anderson, to believe that the matter was well in hand. In early July 1963 he directed Ltd. Col. Yount as follows:

> *You will recall in earlier discussions with Mr. Scott.. that we received estimates from him as to the costs and/or conditions of an unrestricted license for manufacture [of the AR-15] by other sources: also you recall..that Colt was required to pay Fairchild 15% royalty on all repair parts purchased from Colt.*
>
> *I talked with Mr. Barnes..and we have agreed that when negotiations begin for the FY64 buy of the AR-15 with Colt, that we will include in the negotiations:*
>
> *-a government option to purchase the rights and tech data package from Colt at an agreed upon price or other consideration.*
>
> *-that we will negotiate out, what we consider to be exorbitant, the 15% royalty paid to Fairchild..*

Colt's Story

Colt's had already released "selected" drawings and specifications to the Army. However, they had invested a great deal of the firm's own money in their "gamble" on the AR-15, which they were not about to throw away if at all possible. As later summed up by Paul Benke, Mr. Scott's successor as president of Colt's, during the Ichord hearings in 1967,

> *..Our firearms division..acquired the design and exclusive right to manufacture and market..the AR-15 on January 7 1959. We paid $325,000 to Fairchild Stratos and other parties [as noted earlier, Fairchild received only a paltry $75,000 of this money; the remaining $250,000 went to Cooper-Macdonald] for these proprietary rights and guaranteed a royalty on sales against a minimum annual payment if no sales were made.*
>
> *What we bought was* not *a saleable rifle, but a design, a concept, and an opportunity. In fact, at the time of our rights acquisition, the AR-15 had a record of rejection by the Army. If the AR-15 had been at the stage of development attractive to* any *weapons purchaser at the time we could not have bought the..rights at that price - nor in our opinion, for 20 times that price.*

Colt's view was that the 104,000 rifles involved in the FY64 "one-time buy" procurement just wasn't a strong enough incentive to include the rights in any negotiations. Accordingly in September 1963, Mr. Scott formally advised the Army that "Should the sum total of requirements..exceed 500,000 units, we will at that time consider licensing other sources of production and providing manufacturing know-how to them." Meanwhile, he wrote, "Colt's does not intend or propose as a part of or in conjunction with the present procurement of 104,000 rifles to sell or license all or any portion of its proprietary rights to the United States government."

Round One to Colt's

The matter was taken up with Paul Ignatius, the Assistant Secretary of the Army for Installations and Logistics (I&L), on October 3. He attempted to defuse an embarrassing stand-off by setting the record straight: despite General Anderson's assertions, only he, Ignatius, had been responsible for insisting that the rights provision be built into the negotiations. The Defense Department had in fact already approved a one-time, sole-source procurement from Colt's. Mr. Ignatius had included the "rights clause" automatically, he said, because of the Army's usual practice of avoiding sole-source relationships with suppliers. He well understood, he went on, the reluctance of Colt's to discuss rights along with such a small number of rifles.

Therefore, Secretary Ignatius recommended that "we should amend the RFQ [Request for Quotation] to delete the requirement regarding 'Technical Data Package' for the fiscal year 1964 procurement and that negotiations should be continued with Colt after the award to obtain proprietary rights in the event of a possible future requirement.." The Commanding General of Weapons Command, Nelson M. Lynde, felt this was an unfortunate choice, as "it would be very difficult to negotiate the rights necessary for competitive procurement in the future", but the decision had been made. The October 1967 Ichord report, which itself appeared only a scant three months after final settlement of the rights issue, agreed with General Lynde about Secretary Ignatius' FY64 decision:

It is obvious that the Government never fully recovered from the Army's failure to push through an agreement to obtain the rights in 1963 at the time of the first large military procurement...Unquestionably, the Government was in its best bargaining position at that time and lost the advantage...there appeared to be no particular urgency to this procurement; it was considered to be a one-time buy, even though at least two Army studies indicated a possible requirement of well over 500,000 AR-15 rifles during the next 5 years..

Self-Defense with Regulations - The Army Fights Back

On this issue of "lost advantage", the Army chose to defend itself by quoting DOD regulations, which stated that prior to purchase of technical data and rights, a determination was required, "upon a documented record", that:

-there is a clear need for reprocurement of the item, components or process to which the technical data pertains;

-anticipated net savings in reprocurement will exceed the acquisition cost of the technical data and the rights therein.

In the Army's view, these requirements had not been met until General Westmoreland's call for 100,000 XM16E1s in December, 1965.

As noted, contract "508" had been duly put in place over the 1964 New Year. Under its original terms, Colt's supplied the rifle, bipod and case, bayonet, and 20-round magazine, all of which they viewed as proprietary products. As can be imagined, this concept of ownership, fiercely defended on the one side and hotly debated on the other, became the source of much friction between Colt's and the government. Even today, two decades after the "resolution" of the issue in July 1967, it still affects Colt's relationship with the US Army.

Colt's Best Offer

A breakthrough of sorts occurred in the rights issue in October 1964, when at an informal meeting Colt's verbally presented the Army with four different proposals. The first of these established a price of $5,400,000 for the TDP, plus a continuing 5% royalty on production, against which Colt's would give back $10 for every rifle ordered or delivered. The

other three proposals were variations on this cash-plus-royalty theme, but the first one was the most favorable from the Army's standpoint. In effect, it meant that at such time as the Army had purchased 540,000 rifles, Colt's would have given all the money back, with the net cost to the government being only the 5% royalty, which it will be remembered Colt's still had to share with Fairchild.

In any event the Army refused all four offers, an exceedingly unfortunate and expensive decision which they later defended on the grounds that no indications had then existed of an ultimate need for that many rifles. (The Ichord report challenged this, citing Army studies extant at the time which indicated that the AR-15 would likely be procured in quantity through at least 1968).

AWC's Second Attack

Nothing much happened to resolve the uneasy rights stalemate throughout the following two-year period of add-ons to contract "508". Then, as the Army's FY66 procurement grew from 100,000 rifles to over 400,000, General Anderson seized the moment and recommended the transferral of the rights issue to his Weapons Command, where it would be discussed as part of any new rifle order. Colt's again refused to negotiate under these circumstances, hinting broadly that further slowdowns and unforeseen hitches in the delivery of badly needed rifles might result if General Anderson persisted in linking the rights with the purchase, which Colt's saw as "a violation of DOD directives".

Nevertheless, during the early months of 1966 the Army in desperation decided to "tighten the screws". General Anderson asked Lt. Col. Yount to formulate a unilateral plan to establish a second source of M16/XM16E1 production. The PMR's "Flash Report" of February 11 envisaged using Colt's as the prime contractor in conjunction with one or other of the former producers of the M14 - TRW, H&R, or Olin/Winchester. However, the lead time needed to establish such a venture from ground zero was very optimistically estimated at 13 months to first delivery, a schedule that Lt. Col. Yount warned was "an ambitious program which has never been achieved by *any* prior rifle producer".

Beginning in December 1965 Colt's production rate had begun a year-long period of expansion in response to the ever-increasing numbers of rifles being "added on" to contract "508". During 1966 Colt's single-shift production escalated from the previous 8,000 rifles per month to 25,000. Weighing this proven capability against the Project Manager's 13-month "second source" proposal, Secretary McNamara decided that the rifles needed for Vietnam could be procured quicker "by concentrating on that one company", a decision later defended as part of the Army's commitment to the "status quo" extant throughout the period of the SAWS program. (Official recognition of full commitment to the M16 did not come until December 1966, after the release of the SAWS study report). Accordingly, Secretary Ignatius again directed the Army to "back off" in its attempt to include the rights as part of the new contract.

Henceforth, as Col. Yount noted on 19 May 1966, two separate negotiations were to be conducted, "one for the supply contract for XM16E1 rifles and the other for the technical data package and patent rights." Significantly, this compromise led almost immediately to the finalization of contract "0018" in June, which contained for the first time a provision binding Colt's to negotiate "in good faith" so that the government could obtain "an irrevocable, nonexclusive license to manufacture, or cause to be manufactured, Colt's AR-15 rifles...[with] the negotiations..to be completed on or before December 1, 1966."

Explaining the Delays

Congressman Ichord later asked General Anderson why the Army just didn't take the rights, and then let Colt's sue for grievances in the Court of Claims, as was the patentee's "sole remedy" under the US Code. However, as DOD representatives correctly pointed out, both cost and risk were involved. Notwithstanding the fact that the Comptroller General of the United States himself had determined that "the ownership of a patent should not be a deterrent to Federal procurement on a competitive basis", such an action as Mr. Ichord envisaged would be tantamount to the nationalization of private property, and would surely sour the Army's relationship with hundreds of other private-sector contractors who demanded respect for their proprietary rights. More specifically, there was the question of what the court might ultimately allow Colt's, given all the facts of such a case. There was also the cost to the government of further development once the plans to the weapon had been wrested from Colt's grasp, and the risk of going astray in that development. Certainly no help would be forthcoming from the erstwhile proprietor.

An Uneasy Truce - the Disposable Magazine Project

Even after contract "0018" was in place, there remained a great deal of friction and sometimes open animosity regarding various embodiments of Colt's "proprietary rights". One such example was the case of the Army's proposed "disposable" magazine for the XM16E1:

Project: rifles [week of] 25-29 July 1966

XM16E1 rifle program: *Colt's Inc. denied a request for the use of their drawings to develop disposable magazines. WECOM R&D is considering performing reverse engineering on the present magazines and rifles to obtain the required dimensional data.*

It appeared that short of actually stealing Colt's drawings, the Army's only real recourse in the event of such a refusal was, as Col. Yount suggested, to a process called "reverse engineering". That is, the Army engineers could record the measurements of as large a sampling as possible of the part or item in question, in the hope that a full set of both "maximum" and "minimum" allowable dimensions and tolerances would be represented within the sample and thus obtained. Reverse engineering was a risky, time-consuming and expensive process at best.

AMC's General Counsel, Kendall Barnes, explained the problem further in a reply to General Besson's pencilled "What do we do?":

Prior to the inquiry..requesting release of a set of "sanitized" drawings...we..anticipated that Colt's might deny [it].

The problem comes in getting the "mating" dimensions between the magazine and the receiver. This, and the related tolerances, were all that we desired..

This plan has now been altered to having a single contractor prepare a set of drawings of the rifle magazine well and feed control dimensions derived from a physical inspection of a sample of 50 to 100 rifles provided the contractor..

..despite the term used by Col. Yount, this is not truly "reverse engineering". That involves duplicating an existing structure, while here we are merely getting dimensions from an existing structure in order to mate something different with it.

Incidentally, Colt's refusal to furnish the necessary drawings was not motivated solely by a desire to further entrench its sole-source position on this rifle. [Colt's] is of the opinion that furnishing even "sanitized" drawings of the type we requested would constitute a sub-license under the terms of its license from Fairchild.

The issue of such sub-licenses was indeed one of Colt's continuing worries for, under the terms of the initial Colt/Fairchild agreement, Colt's was liable for royalty payments to Fairchild on *all* production, regardless of who did the manufacturing. Furthermore, as a result of the fully-curved 30-round magazine development program the wide variances in magazine/receiver dimensions were well known, and constituted a source of considerable embarrassment to Colt's management.

A Fight to the Finish

Meanwhile, despite the December 1966 deadline built into contract "0018", production rights negotiations dragged on well into 1967. In April, a short-lived plan was devised whereby Colt's themselves would establish a second manufacturing line. This was costed-out by the PM's office for comparison with both the existing sole-source arrangement and a full-scale reverse engineering proposal. This latter plan was pursued virtually right up to the day of final agreement, with Col. Yount finally recording "Notification received on 27 April indicated that the..agreement is imminent for the rights to this [M16/XM16E1] family, therefore, the reverse engineering RFPs [request for proposal] will not be used."

The following month it appeared that Col. Yount had spoken too soon:

Colt's Inc., has indicated complete refusal to enter into a contract for the Technical Data Package [TDP] which contains a "Liquidated Damages" clause...or penalty for late delivery of the TDP..

Colt's..remains very adamant that it will probably take at least six months time to deliver the TDP after receipt of a signed contract even if the penalty clause [$8,333.34 "liquidated damages" for each calendar day of non-delivery, or $250,000.20 per calendar month] is removed. Further, due to Colt's apprehension on the specifics of the contract, Colt's will probably require more time..so that a complete understanding..may be reached..

277. Left and right side views of a (Colt model 639) submachine gun (the export model of the XM177E2), serial no. 9560079. Fitted with an 11.5" barrel and (third type) "birdcage" flash suppressor. Stock extended (above) and retracted (below).

278. Left side view of a late Colt model 653 M16A1 Carbine (14.5" barrel) serial no. 9279755, partially stripped. Overall length (stock retracted): 29.8" (76cm). Weight, with loaded 30-round magazine: 6.9 lbs. Note the compact "shortie" buffer.

279. Truly United? A scene at the US Army exhibit at the New York World's Fair, showing Colt Firearms Division president Paul Benke testing his skill with one of two modified, light-beam-emitting M16A1s, set up to illuminate the target when a bull's eye was scored. Looking on is the Army's head of exhibit operations, Col. Lloyd S. Sullivan.

Agreement at Last?

Letter contracts for the manufacturing rights and the TDP of both the M16/XM16E1 rifle and the XM177/XM177E1 submachine gun were signed on June 30, 1967, thus finally providing the government with the documentation necessary to open the bidding for a second source of supply. Ironically, the terms finally agreed upon were much the same as had been contained in Colt's first verbal proposal back in October 1964, except now the $4,500,000 cash payment was no longer subject to any per-rifle rebate, and the royalty was increased to 5 1/2% on all future weapons and repair parts purchased by the government. In addition, regardless of any subsequent second-source arrangements, the Army agreed to contract for 27,500 rifles per month from Colt's on a sole-source basis, which guaranteed the production of an additional 632,500 Colt-made rifles through April 1970.

Announcement of the final signing of the rights agreement formed part of the Project Manager Rifle's significant action report for the week of 26-30 June 1967, the first such report not bearing the signature of Col. Yount as project manager.

Chapter Eighteen

BROADENING THE BLACK RIFLE'S WARTIME PRODUCTION BASE

Colt's On Strike

The employees of Colt's had greeted the news of government acquisition of the manufacturing rights to the M16A1 rifle by going out on what became a two-month strike. This was especially worrisome to the harried new acting PMR because, as

..Accelerated production of rifles during June 1967 offset the effect on rifle production for the first two weeks in July, which was previously scheduled for employee vacations. Since there are also some weapons in government stocks, the primary impact of the work stoppage is in spare barrel assemblies. The CG, US Army Weapons Command has

noted, spare parts (especially barrels) were in short supply in mid-1967 Vietnam, due to wear, rusting and fouling (largely from tracer bullets) on a scale far greater than expected. Lt. Col. Engle noted:

recommended..that the Department of the Army seek a Taft-Hartley injunction based on the critical need for barrel assemblies and an anticipated shortage of M16A1 rifles after 15 August 1967. Colt's barrel production at 4,000 per month has become insufficient to meet demands. Projected demands are estimated to reach 11,800 barrels per month..

Back to the Bargaining Table

Throughout the fall of 1967 the Project Manager Rifles was thus faced with a number of major problems (to say nothing of the SPIW program). These included getting the "bugs" out of the M16A1's TDP, procuring enough new rifles to meet the accelerating demands of the war, and maintaining the rifles already in service, fitted as they were with what Dr. Carten was soon to call "non-interchangeable parts of unknown quality".

Of the initial list of 26 firms interested in becoming the M16A1's second source of production, 20 attended the pre-solicitation conference on October 3. The Project Manager's report noted:

..nine firms made the $1,000 bid deposit to receive the initial TDP and two M16A1 rifles. Those firms making bid deposits are as follows:

1. Aeronutronics Division of Philco-Ford
2. FTS Corporation, Denver, Colorado
3. General Electric, Springfield [Armory] Massachusetts operation
4. General Motors, Hydramatic Division
5. Harrington & Richardson, Inc.
6. Physical Sciences Corporation, subsidiary of Friden
7. Stetson Ross Mfg. Co., Seattle, Washington
8. Olin-Mathieson, Winchester Division
9. ZD Products, El Segundo, California

By the end of the year this list had altered slightly:

Project: rifles [week of] 18-22 December 1967

..Twelve firms initially made bid deposits for receipt of Technical Data Package. Eight..remain interested in this production:

Bauer Ordnance Company
Kaiser Jeep Corporation
Cadillac Gage Company
Maremont Corporation
Stetson Ross Mfg. Company
Physical Sciences Corporation
General Motors (Hydramatic Division)
Harrington & Richardson

Four firms have withdrawn:

Olin-Mathieson
General Electric (Springfield Division)
Philco-Ford Corporation
Z-D Products

The Short-Lived GM Hydramatic "Sole Source" Award

Secretary McNamara approved the Army's plans to expand production in early March of 1968. In a surprise move which seemed to sweep aside all the work being done by the newly-appointed "Source Selection Board", which was carefully screening all the interested firms to ensure satisfactory contract performance, Col. Engle reported:

..The following actions will be taken for expansion of the rifle base:

1. Maximum expansion of Colt's to level off at 50,000 per month. This will require approximately 107,000 additional rifles to be funded in FY68.

2. Expansion of the second source now in progress of selection to provide a maximum feasible buildup and levelling off at 25,000 rifles per month.

3. A sole source award to Hydramatic Division of General Motors Corporation at a maximum schedule to be negotiated and to level off at a rate of 25,000 per month. A letter order contract for a one year buy of approximately 162,000 rifles is anticipated with first deliveries in January 1969, and to reach a maximum production rate of 25,000 rifles per month in October 1969.

These plans soon gave way, however:

Project: rifles [week of] 25-29 March 1968

M16/M16A1 Rifle Procurement: *The previous plans for expansion of a second source and establishment of a third source have been rescinded. In lieu thereof and in order to gain maximum accelerated production, a decision has been made that all contractors who submitted an acceptable technical proposal will be invited to begin intensive negotiations leading to the selection of two sources to reach a multi-shift rate of 25,000 per month each as fast as possible..*

Second-Source Production Begins - The GM Hydramatic and H&R Contracts

Letter contracts were awarded on 19 April to GMC's Hydramatic Division of Ypsilanti, Michigan, and Harrington & Richardson, Inc., of Worcester, Massachusetts, with initial deliveries scheduled for February, 1969. The two contracts, Hydramatic's DAAF03-68-C-0048 and H&R's DAAF03-68-C-0045, were definitized in December 1968, each for a total of

240,000 M16A1 rifles. As an indication of the Army's pressing need for new rifles, each contractor was scheduled to reach maximum output of 25,000 rifles per month by November, 1969. Interestingly, when that time arrived, a recommendation made by the Project Manager had been approved, and "the requirements to make available the facilities, tooling and test equipment required for production of the XM177/XM177E2" had been deleted from both second-source contracts.

Fresh Congressional Concern

The Ichord report had stated bluntly that four years was altogether too long a time for the government to take to acquire Colt's TDP, or at least to establish a second source of procurement for the M16A1. Ironically, however, as soon as the Army announced the GM and H&R second-source contracts, fresh congressional rumblings were heard. This time the concerns focussed on both the Army's choice of contractors and the price they were to be paid.

Senator George McGovern, for one, had the "facts" before him: Colt's was making the M16A1 for $104, while H&R had been granted $250 per rifle (including apportioned tooling costs), and GM's Hydramatic Division was to receive $316 apiece. These new prices seemed outrageously high. True, aside from the earlier M39 20mm cannon project, Hydramatic was a newcomer to the small arms production field and thus had a costly "learning curve" to underwrite, but H&R had a long and well-documented history of marginal quality performance in its manufacture of M1, T48 and M14 rifles. Furthermore, several of the unsuccessful bidders noted above were work-needy defense contractors with considerable small-arms experience. For example, the Maine-based Saco-Lowell Shops, a division of the Maremont Corporation, produced the successful 7.62mm M60 machine gun, and the Cadillac Gage Corporation had developed the Stoner weapons system. Saco-Lowell's bid, for one, while higher than Colt's, was lower than GM's.

In the spring of 1968 this renewed congressional interest in rifle procurement led the chairman of the Senate Preparedness Subcommittee, Senator John Stennis, to appoint a Special M16 Rifle Subcommittee chaired by Senator Howard Cannon. In the House of Representatives, the Ichord Subcommittee on the M16 Rifle Program was also directed to resume its activites. Both bodies zeroed in on a fresh examination of the Army's second source awards.

Back at Rock Island, the Project Manager, Col. Isaacs, reported:

Project: rifles [week of] 27-31 May, 1968

..Brigadier General Shaw, USMC Ret., and Mr. Neal of the Stennis subcommittee visited Colt's on 28 May..H&R and Maremont on 29 May..and GMC-Hydramatic and Cadillac Gage on 31 May...The purpose of the visit was to examine facilities and gather information from the successful and unsuccessful bidders..

The Army responded to this renewed criticism by opening the books on its "standard method" of contract award, which in this case had begun with the appointment of the mentioned Source Selection Board comprising 65 men knowledgeable in one or another phase of military small-arms manufacture and procurement. The Board had subsequently evaluated all the prospective contractors on the three crucial issues of managerial capability, technical expertise, and financial competence.

The Army's newly-accelerated production schedules were announced in August: Col. Isaacs recorded that "In order to meet contractual requirements, the government must buy 933,000 M16 rifles in FY69". In the light of this the Board "re-evaluated" its findings before passing them on to an Advisory Council of "senior officers and civilians", where the upshot was that only GM and H&R were judged capable of rising swiftly and reliably to the challenge of volume production on the Army's desperately-needed rifles.

The Cannon subcommittee released its final report in September, summarizing the Army's second source awards as a "most inept performance". On a visit to the Hydramatic plant, for example, the subcommittee discovered that the Advisory Council had approved GM's proposal to construct the requisite test range facility in the rafters above the manufacturing floor itself, notwithstanding such serious drawbacks as noise, possible danger from ricochets, and the hazards of eventual lead poisoning in the plant below due to the inevitable sifting down of highly toxic powder and primer gases and residues. Senator Cannon, with a twist of irony, was prompted to opine that such a range "promises to be a unique facility indeed".

Getting What You Pay For

Congressional nit-picking aside, it soon became apparent that GM's Hydramatic Division was earning its extra pay by instituting quality production in record time. As the Project Manager noted approvingly,

Project: rifles [week of] 14-18 October 1968

M16 Production Team: *..Progress at GMC continues at a rapid pace. No problem is anticipated in meeting the in-house schedule. H&R will require continued close watching and the addition of four (4) Walter Kidde experts, a more positive approach is already evident. Inspection and engineering assistance has been provided by the government to ensure H&R progress..*

The following week, Col. Isaacs recorded that the Assistant Secretary of Defense (I&L), the Assistant Secretary of the Army (I&L), the Commanding General of AWC, Roland B. Anderson "and other senior officials" had visited the three M16A1 contractors, and described the results of the trip as follows:

Colt's is on schedule for their buildup to 50,000 rifles per month..

H&R has shown marked improvement. In-house build schedule for 500 in December is unchanged. H&R successfully fired four (4) rifles which they fabricated.

280. Closeup of receiver markings on a typical M16A1 as manufactured by the Hydramatic Division of General Motors Corporation. Note serial no. (28th rifle in GM's assigned serial no. range, which began at no. 3,000,000).
Colt photo by Ed Guinan

GMC: Excellent progress with a promise to deliver..ahead of schedule. GMC has produced two (2) weapons, one of which was fired during the visit. Both weapons have met all functional requirements..

By October 28 a General Motors endurance rifle had fired 10,000 rounds with only one extractor spring failure at 4,800 rounds. The Project Manager's weekly report concluded with the ominous news that union members at the Tri-Ordinate Corporation, suppliers of heavy automatic machine tools to all three M16A1 producers, had voted to go out on strike. While later called off, at the time this threatened serious setbacks and delays at both Colt's and H&R. GM's Hydramatic Division on the other hand, erstwhile builders of the M39 20mm Automatic Cannon, demonstrated some original thinking:

Project: rifles [week of] 4-8 November 1968

..Action has been taken to eliminate any slippage in delivery of M16A1 rifles due to lack of production machines by authorizing Hydramatic to contract with Tri-Ordinate for final assembly and shipment of machines from subcontractor plants..

Failures at H&R

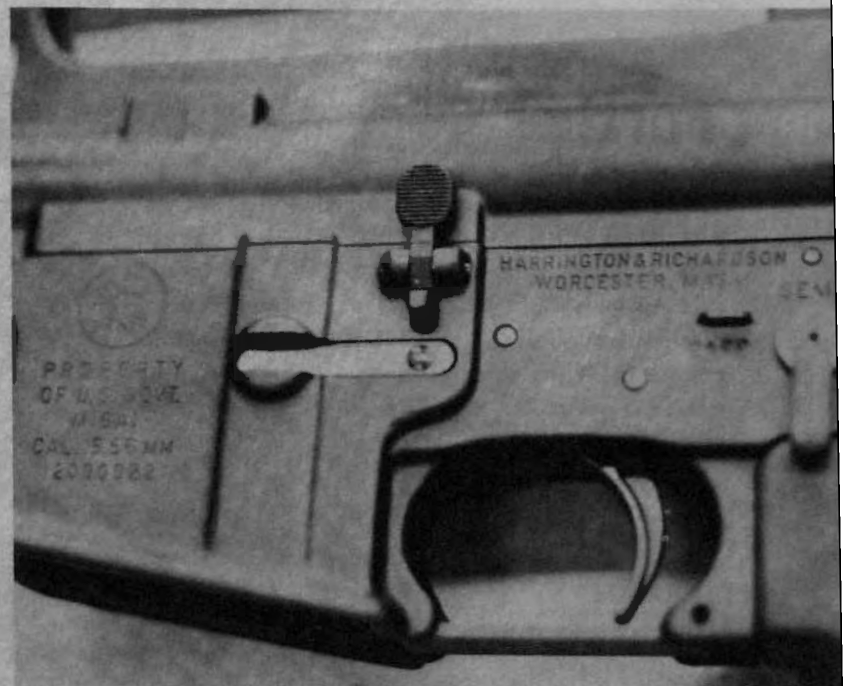
By the time of contract definitization in December, GM had offered 100 rifles to the government for acceptance, two weeks ahead of a similar first quantity from H&R. Indeed, it appeared that H&R was by no means yet "out of the woods":

Project: rifles [week of] 9-13 December 1968

Weapon Tests Failure, H&R:

Two (2) weapons have failed the 6,000 round endurance requirements. The first failure was attributed to a fractured bolt assembly. An investigation to determine the exact cause is being conducted by the contractor, with assistance provided by WECOM and MUCOM personnel. The contractor's preliminary determination indicates dimensional error introduced during the chrome plating of the chamber. Correction of this action is being developed.

The second weapon exceeded the allowable malfunctions for "Failure to Chamber". The contractor is presently investigating to determine the causes.



281. Closeup of receiver markings on a typical M16A1 of Harrington & Richardson manufacture. Note the lion-in-circle trademark and H&R serial no. range, which began at no. 2,000,000. *Colt photo by Ed Guinan*

282. Colt's "M16A1 5.56mm Weapons System" as it had evolved circa 1970.

Further Contracts with Colt's and GM Hydramatic

Also in 1968, the Army exercised two contract options to procure over 700,000 additional M16A1s from Colt's. The second of these, letter contract DAAF03-C-69-0068 for 313,413 rifles, was the final placement necessary to fulfill the FY69 rifle requirement. For the week of 9-13 December Col. Isaacs recorded that priorities had been established at Colt's in the following order: "First - rifles in accordance with contract schedule; second - repair parts as scheduled by the contracts; and third - any excess production in the form of rifles up to a maximum of 50,000 per month".

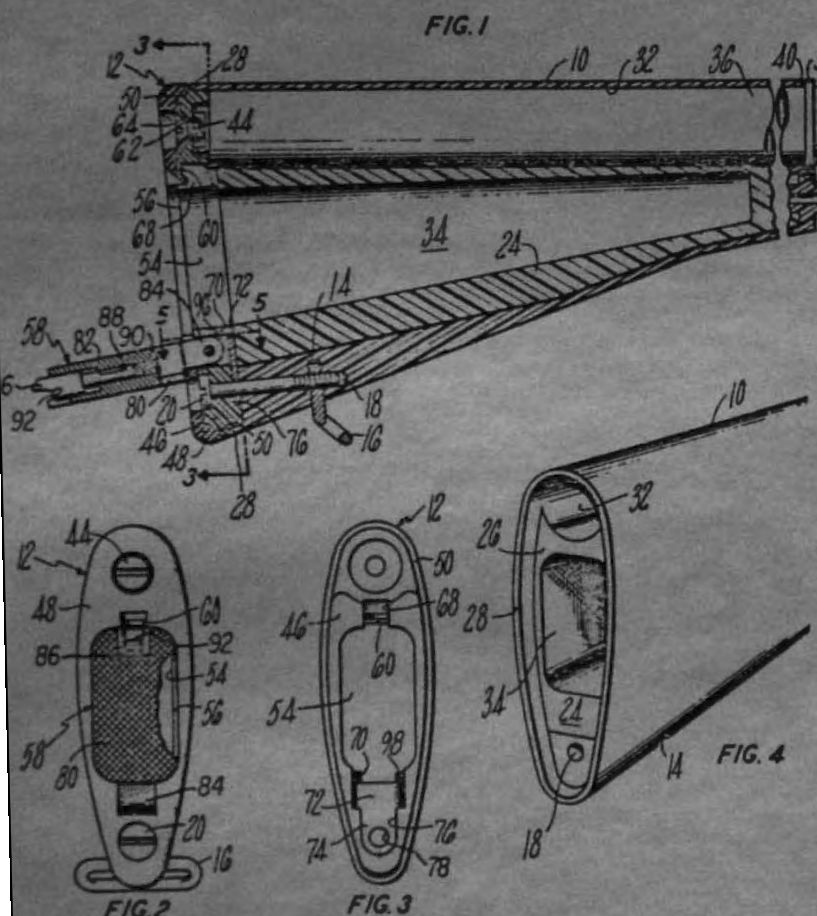
The US Army Weapons Command's *Procurement History and Analysis of M16 Rifle* (document no. AMSWE-PPE-72-01, dated 2 August 1971) summed up the latter history of the war-swollen 5.56mm rifle contract awards through to the then-present as follows:

..Colt's Inc. was selected as the primary supplier of M16/M16A1 rifles because of their previous experience as a supplier and the inability of the government to have second and third sources available so soon after the Technical Data Package had been negotiated.

Letter contracts DAAF03-68-C-0061 [awarded June 1968] and DAAF03-69-C-0021 [awarded October 1968] were modified to be one contract and the definitized modification PZ67 of DAAF03-69-C-0021 (FFP) was signed November 1969 for 740,803 M16A1 rifles and 1,000 M16 rifles... Modification to the contract decreased the total price from $77,138,882.00 to $75,984,623.45 by changing configuration on 135,001 rifles from M16A1 to M16..

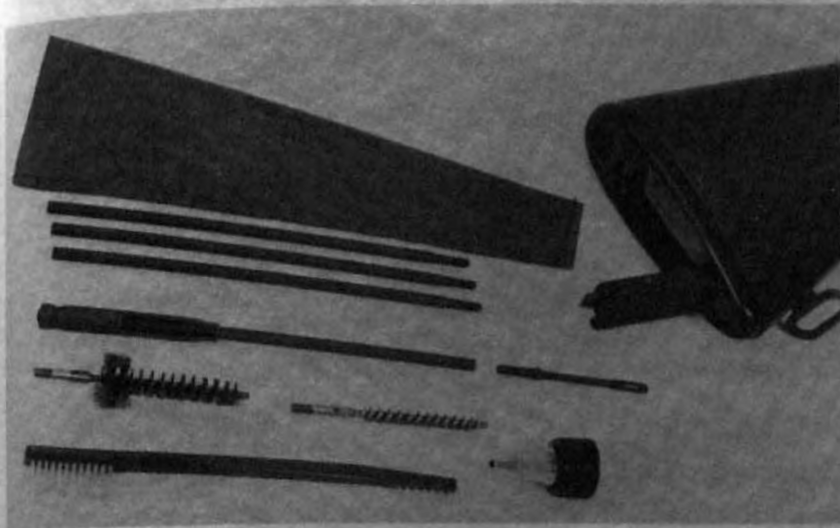
..Request for Proposal [RFP] DAAF03-69-R-0039 went to the three suppliers of the M16A1 for bids on FY70 and FY71 rifle buys. Colt's Inc., Harrington & Richardson, Inc., and General Motors Corporation, Hydramatic Division all responded..

H&R and GMC had been set up as second and third source suppliers for the purpose of making this contract competitive...The [July 1969] award..to the two lowest bidders was justified because it was "in the interest of National Defense that the Industrial Mobilization Bases established.. be kept in operation, to keep two existing lines and specialized personnel in an active status." Each contractor submitted prices for 40,000..30,000..and 20,000 weapons per month..

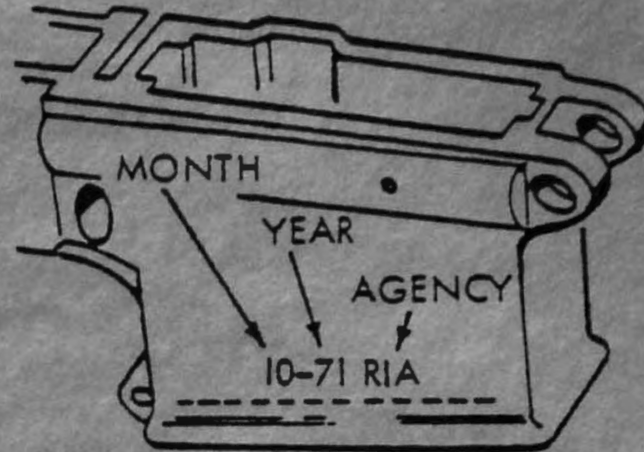


283. Figs. 1 to 4 from US Patent no. 3,618,248, granted to Henry A. Into and John Jorczak, entitled "Buttstock Assembly with a Latchable Door for a Compartment Formed Therein". Finally, cleaning materials for the M16A1 had a home right inside the rifle. *US Patent Office*

284. Late-style sectioned M16A1 barrel circa 1971-72, showing the chrome-plated bore and *chamber. Identified by stamped letter "B" about 1 7/8" from muzzle face, or marked "Chrome Bore".*



285. The new buttstock trap, showing the late M11E3 (4-section) cleaning rod, chamber and bore brushes, and 2-oz. plastic bottle of LSA.



286. Illustration from Depot Maintenance Work Requirement (DMWR) 9-1005-249, showing authorized method of indicating overhaul to an M16A1, with markings, about the size of those in the maker's legend on the left side of the receiver, permanently applied before refinishing and showing month, year and Agency performing overhaul.

Contracts were signed with Colt's Inc. and Hydramatic.. on the basis of their original proposals. Colt's was awarded a contract [DAAF03-70-C-0001] for 458,435 M16A1 rifles at a cost of $41,158,294.30. GMC was awarded a contract [DAAF03-70-C-0002] for 229,217 M16A1 rifles at a cost of $23,783,555.92...[H&R] were experiencing delivery problems on their [original] contract and evidently felt that the 20,000 units..would be more advantageous to them..

This was the first contract for the M16 rifle in which bidding was competitive..

Chapter Nineteen

AN EXAMINATION OF THE "END RUN" METHOD OF RIFLE PROCUREMENT

Competitive procurement of the M16/M16A1 rifle and its ball, blank and tracer cartridges comprised by this time a vast and complex "universe" indeed, due to the many forces which had indirectly but powerfully influenced the program.

The "Whiz Kid" Legacy

Gene Stoner himself has pointed out that the AR-15 and especially his ".222 Special" cartridge were really just first attempts, and likely not the best possible designs in every detail. As we have seen, this was subsequently proven to be true, although the first examination at Aberdeen in 1958 confirmed that the system possessed no significant faults which could not have been corrected, given a normal course of development.

Dr. Fred Carten's "means to an end" denial of the AR-15's merits in 1958, followed by exaggerated OSD claims after its resurrection as a "fully developed" weapon system in 1963, set the AR-15 procurement project up for real trouble. Both of these courses led, ironically, to the same pass: the virtual prohibition of a normal course of engineering development, before *and* after the Army was ordered to make the "one-time buy" procurement.

In addition, warnings that the cartridge was inherently incapable of consistently meeting some of the stated "design goals" went unheeded by OSD, who then insisted that the Technical Coordinating Committee adopt these goals as inalterable requirements. The OSD veto of Frankford's proposal to revert to a more lethal bullet (chapter 8) forced a switch in propellant. While this satisfied the chamber pressure/velocity requirement, it led to further complications in the rifle itself. These in turn engendered the whole series of "fixes" (harder bolts, stiffer extractor springs, new buffers, new magazine catches) which the Ichord report had so criticized. However, by the time the Army finally got a firm grip on the rifle's Technical Data Package in 1968, the M16A1's field malfunction rate was consistently below 1 per 1,000 rounds.

Colts' Contribution

Colt's too had reason to lament the lack of a standard Ordnance-sponsored engineering development program. They had uncovered the "tip of the iceberg" during the 30-round magazine project, wherein was confirmed the limited degree of interchangeability which existed in the rifle/magazine interface of many (nobody could really tell *how* many) rifles, already government-inspected and in the field. As witness their reluctance to participate in the Army's "disposable" magazine program, it appeared that they were loath to share the full extent of this and other dimensional problems with the Army until the very last possible moment. Indeed, under the terms of the rights agreement Colt's had insisted on doling out the TDP to the Army in portions, from June to December of 1967.

The TDP's "140 Areas of Potential Interference"

Once the drawings and documents were all in hand the Army had contracted for an independent study of tolerance relationships in the M16 rifle. In the words of Dr. Carten's "Blue Ribbon" report:

In February 1968 Comprehensive Designers, Inc. (CDI) reviewed the package and uncovered some 140 areas of potential interference. The corrective actions recommended by CDI were undertaken in conjunction with Colt, and the new rifle producers were alerted to the changes..

..The production of large quantities of rifles without a government technical data package, while in consonance with the Gilpatrick directive [chapter 8], has undoubtedly resulted in the introduction into the supply system of large numbers of weapons with non-interchangeable components of unknown quality.

Ten Special Tests at Frankford Arsenal

With the TDP in hand, the Army was finally equipped to undertake the first genuine examination of *all* the planets in the M16's universe, in a series of tests significantly *not* prompted by any particular problem *per se* but designed to get at the technological truth once and for all regarding the specialized behavior of the M16's "unique" gas system. Equally important, the Army wanted to know more about the exact state of the nation's existing inventory of Colt-made M16/M16A1 rifles:

United States Army

Frankford Arsenal

Special Tests of 5.56mm Ammunition

February 1968

An M16A1 Rifle System Test Coordinating Team was established at Frankford Arsenal by the direction of the Commanding General, US Army Munitions Command..to..Frankford Arsenal, 15 November 1967..to conduct special tests as assigned.

These special tests are..designed to provide the Project Manager with operational data of the M16/M16A1 Rifle Systems under a variety of conditions and with emphasis on comparison of performance between the two current types of propellants loaded into 5.56mm ammunition.

The scope of the tests encompassed verification of a bursting bullet problem in tracer ammunition loaded with WC846 propellant..; further definition of areas of fouling and their effects on weapon performance [and] investigation of reported extraction difficulties...The conduct of these tests expended a total of approximately 420,000 rounds (ball plus tracer cartridges loaded with WC846 and IMR types of propellant) and utilized [150] new M16A1 rifles.

The following are some of the salient findings of Frankford's ten tests, beginning with a dimensional survey of the 150 new rifles:

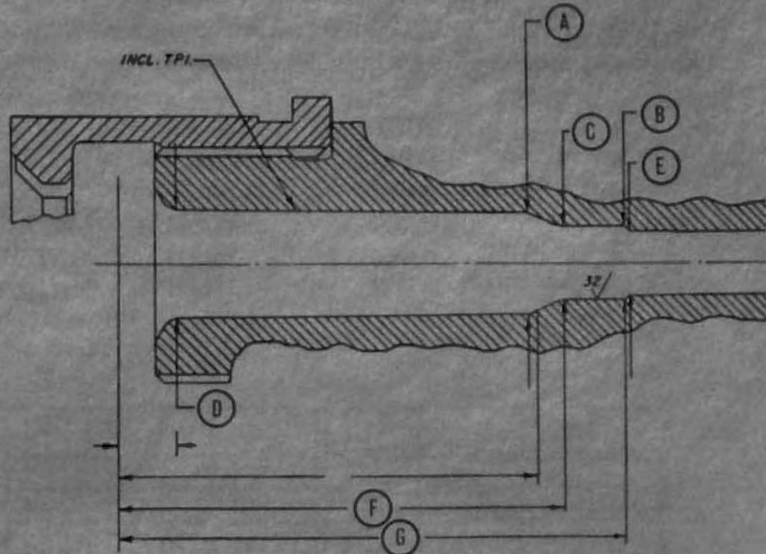
A Dimensional Survey of M16A1 Rifles Used for Frankford Arsenal Tests

..A dimensional survey was made on these [150] rifles prior to their use in any of the tests. Since all rifles were committed.. it was necessary to conduct the survey in the brief period between receipt of the rifles and commencement of testing..

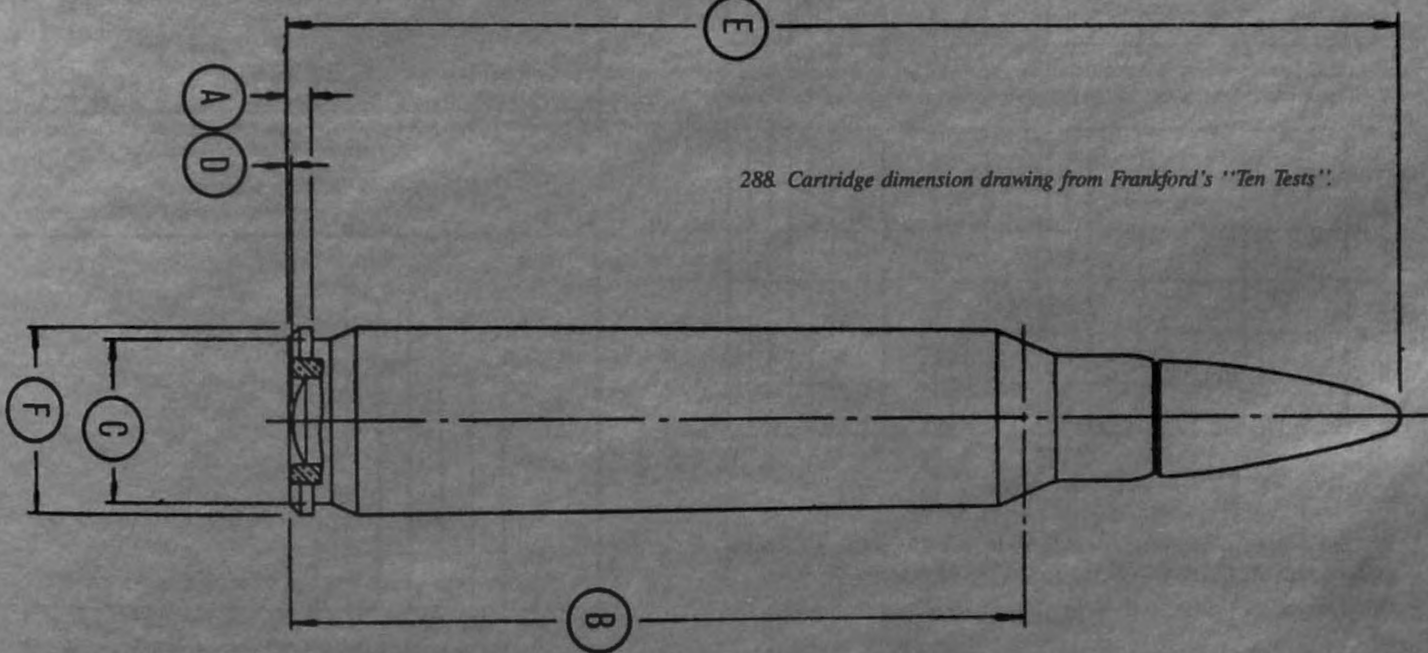
Chamber dimensions

[All 150 rifles were measured at points shown in figure 287. Results are summarized as follows:]

Reference point	Specified dimension (inches)	No. rifles out of tolerance	Percent out of tolerance
A	0.3553+ 0.002	21	14.4
B	0.254 + 0.002	29	19.9
C	0.255 + 0.002	67	46.0
D	0.3769+ 0.002	113	77.5
E	0.2265+ 0.002	5	3.4
F	1.5520+ 0.006	42	29.2
G	1.7720+ 0.006	45	31.2



287. Chamber dimension drawing from Frankford Arsenal's "Ten Tests".



288. Cartridge dimension drawing from Frankford's "Ten Tests".

Dimensions, 5.56mm M193 Ball Cartridge

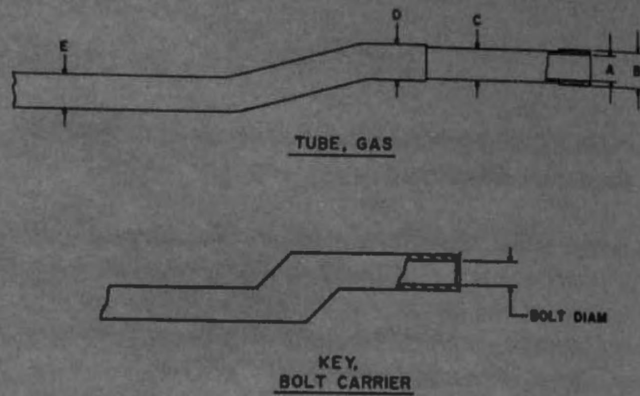
[As a point of reference, the specified dimensions of the M193 ball cartridge (figure 288) are as follows:]

Reference point	Specified dimension (inches)
A	0.045 - 0.007
B	1.500 - 0.006
C	0.3325- 0.007
D	0.008 - 0.008
E	2.260 - 0.025
F	0.378 - 0.007

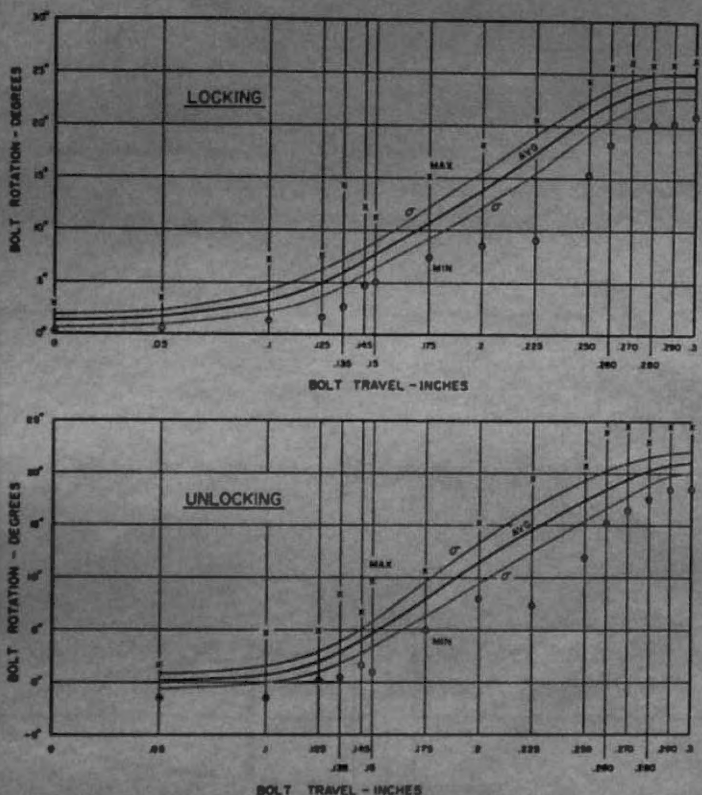
Dimensions, Propellant Gas Tube and Bolt Key

[figure 289; dimensions in inches:]

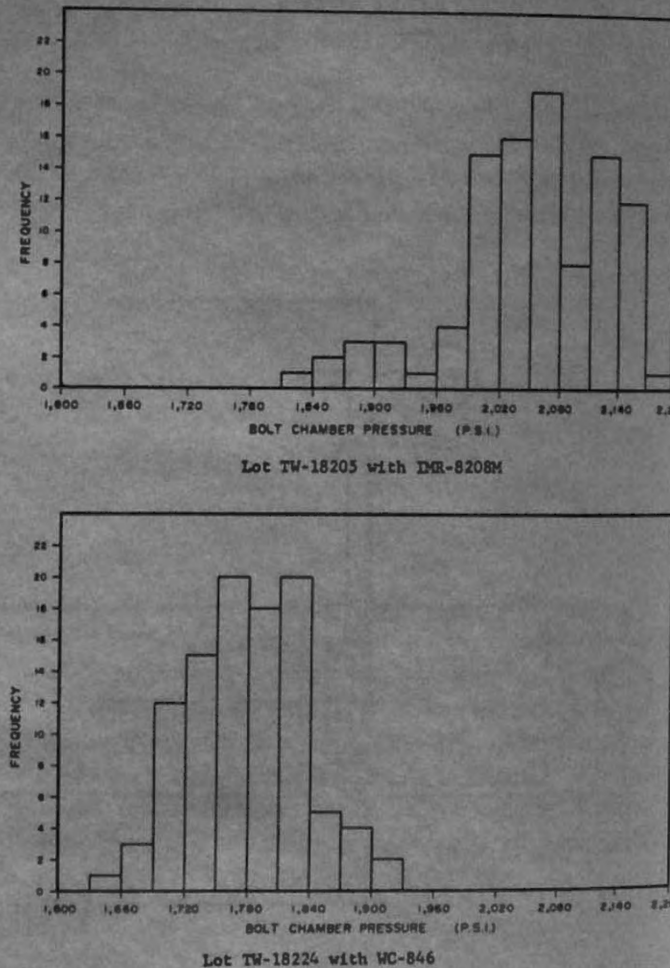
Reference point	*Average*	*Maximum*	*Minimum*
A	0.1151	0.1200	0.1090
B	0.1793	0.1800	0.1780
C	0.1703	0.1720	0.1687
D	0.1799	0.1807	0.1795
E	0.1798	0.1803	0.1795
Bolt key	0.1804	0.1810	0.1800



289. Gas tube and bolt carrier key, showing location of dimensions measured.



290. Bolt rotation variations measured during Frankford's "Ten Tests", showing bolt travel for both locking (above) and unlocking (below).



291. Chart from Frankford's "Ten Tests" showing bolt carrier cavity peak pressure histograms.
Above: ammunition lot TW-18205 (IMR 8208M).
Below: ammunition lot TW-18224 (WC846 ball propellant).

Determination of Extent and Effects of Residue in the Gas Transmission Tube of the M16A1 Rifle

..The producer of the M16A1 rifle reported the following to the Project Manager..:

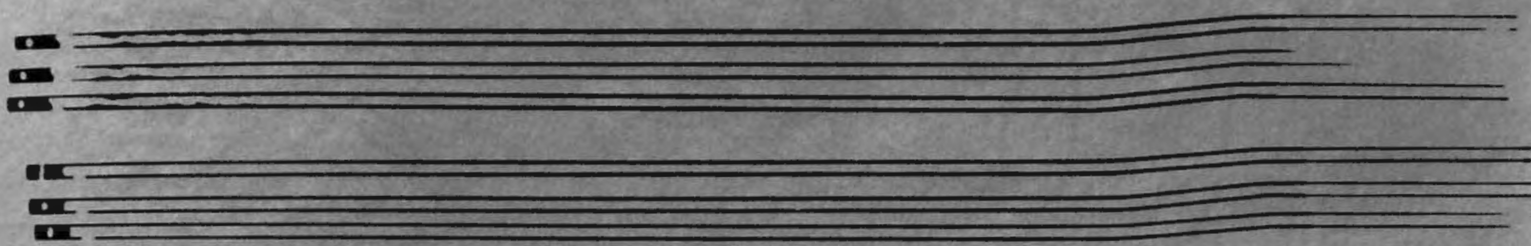
1. That ammunition lot RA-5317 (WC846 propellant) caused excessive fouling in an M16A1 rifle gas tube which resulted in numerous weapon malfunctions and the rejection of a group of rifles.

2. That ammunition lot RA-5244 (WC846 propellant) produced no such problems.

3. That ammunition lot TW-18179 (IMR 8208M propellant) is excessively "dirty" and could be expected to cause weapon stoppage.

..The [test] procedure was to block the chamber end of the barrel and time the flow of a known volume of air through the gas tube.

The firing of the rifles was accomplished in the manner specified in SAPD-2538..Endurance Tests. The five rifles.. are tabulated below.



292. X-ray photograph of M16A1 test rifle gas tubes, showing fouling buildup after 2,000 rounds of M193 ball ammunition. Note that fouling produced by ball powder (WC846) is most noticeable and is concentrated near gas tube inlet (above 3 examples) while buildup from IMR 8208M propellant is less noticeable and occurs farther down the tubes, closer to the tube bend (below 3 examples).

Rifle serial and status	Cartridge lot no.	Propellant type	Air flow measurements (sec) Start	3,000 rds	6,000 rds
858816 (new)	RA-5244	WC846	113.3	118.5	124.0
850119 (new)	RA-5318	WC846	114.0	132.0	167.0
850965 (new)	RA-5317	WC846	116.3	134.0	141.5
848235 (new)	RA-5317	WC846	112.4	120.5	121.0
872132 (failed at Colt's)	TW-18179	8208M	118.9	124.0	130.0

..X-ray examination of the gas tubes very clearly shows fouling deposits in the tubes. There appears to be good agreement between air flow measurements and the visual appearance in X-rays of the amount of fouling. Gas tubes from rifles firing..WC846 propellant show fouling residue on both sides of the gas tube inlet and extending rearward for one-and-a-half to three inches...8208M-loaded cartridges [produce] fouling buildup further down the gas tube (toward key end) in the region of tube bend..

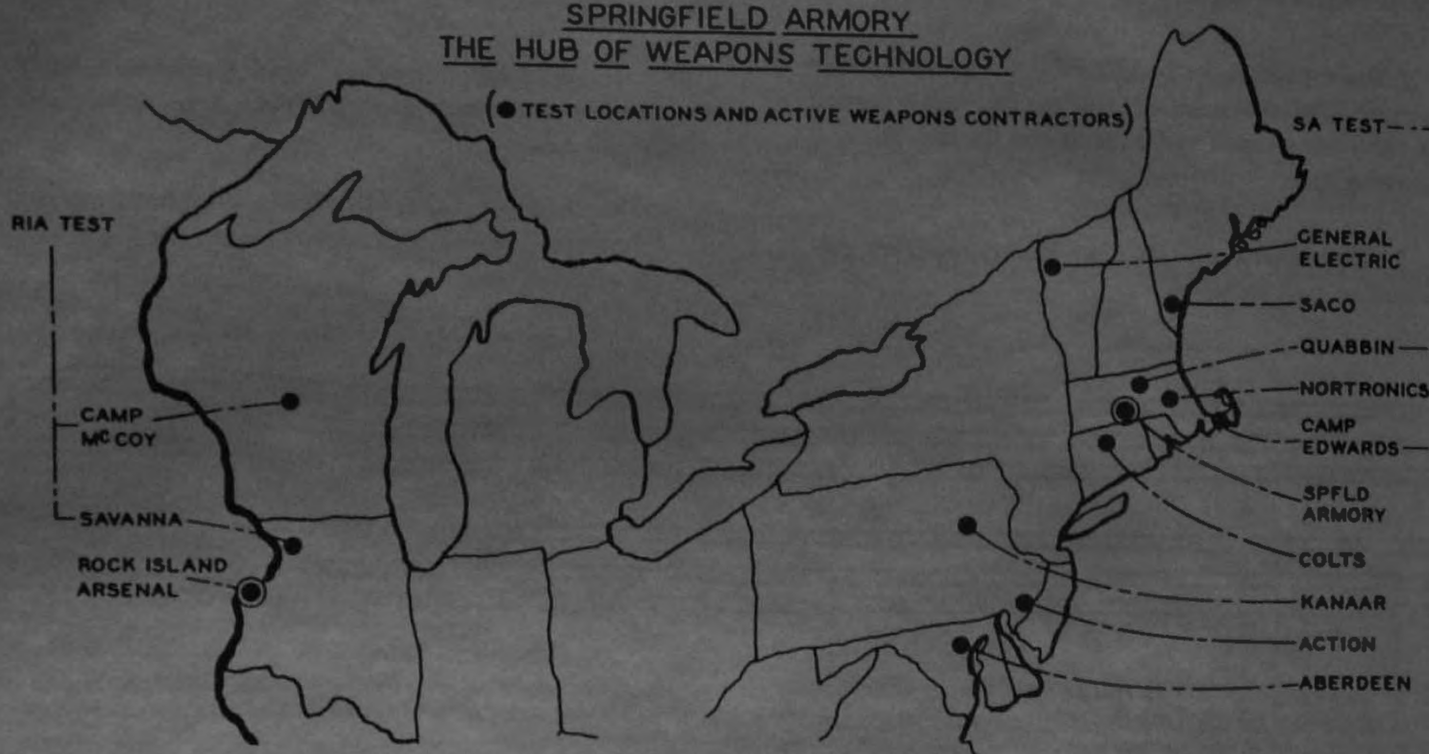
Although the residue buildup in the gas tubes of all rifles steadily increased, there was no corresponding increase in weapon malfunction during the 6,000 round portion of these tests. Extended firing..(beyond 6,000 rounds) indicates that increased gas tube fouling does lead to short recoil and weapon stoppage.

There was no indication of excessive fouling of the gas tube from..lot RA-5317 as alleged by Colt's. Rifle [872132], which failed similar testing at Colt's, performed satisfactorily with this lot of ammunition..

..There were no differences in results of sufficient significance to indicate that any one of the propellant lots might be more likely to induce weapon fouling than any other lot..

Further, long-term testing involving simulated fouling of M16A1 gas tubes was undertaken, as it was admitted that the relationship of residue accumulation to actual system performance remained unknown.

Springfield's Final Hour



FROM ROCK ISLAND

To	Miles	Hrs	Mode
Savanna	77	1 1/2	GOV
Aberdeen	832	6	Air
Camp McCoy	221	5 1/2	GOV
Gen Electric	1359	7 1/2	Air
Colts	1087	5 3/4	Air
Saco	1232	7 3/4	Air
Nortronics	1147	6	Air
Kanaar	865	5 1/4	Air
Action	911	4 1/4	Air
TOTAL	7731	49 1/2	Air 96.2%
			GOV 3.8%

FROM SPRINGFIELD ARMORY

To	Miles	Hrs	Mode
Quabbin	27	3/4	GOV
Aberdeen	309	6 1/4	GOV
Camp Edwards	140	3	GOV
Gen Electric	202	5	GOV
Colts	26	1/2	GOV
Saco	200	4 1/4	GOV
Nortronics	103	2	GOV
Kanaar	243	4 1/4	GOV
Action	230	4	GOV
TOTAL	1480	30	Air 0%
			GOV 100%

293. In a last-ditch snipe at Secretary McNamara's closure order, the "Report of Springfield Armory for the Retention of Mission.." included this map showing the relative proximity of the Armory ("The Hub of Weapons Technology") to the main industrial contractors and military test facilities of the day. It was ignored.

As a result of Secretary McNamara's adamant closure order, discussed in chapter 11, Springfield Armory had perforce played a diminishing role in the Army's small arms affairs as the date of that station's permanent dismantlement drew nearer. The final moment came on schedule, in April 1968. Before the closure announcement, Springfield had supported a civil-service small arms R&D department some 480-strong. As part of the post-Armory relocations Secretary McNamara had ordered this "facility" transferred to Weapons Command Headquarters at Rock Island Arsenal, but had reckoned without the people. Angered and frustrated by what appeared to them the senseless destruction of the very core of the nation's small arms engineering development capability, only twenty - 4 % - of the R&D staff could be persuaded to make the long trek west to Illinois: the rest chose early retirement or disappeared into other jobs, mainly in the Springfield area.

The loss of the civilian R&D engineering team goes a long way toward explaining why (aside from Colt's fierce protection of its proprietary rights) the development of all sorts of really useful peripheral devices for the M16, i.e. open-bolt conversions, grenade launchers, noise and flash suppressors, short barrels and extended-capacity magazines, proceeded at such a snail's pace. Suddenly there were precious few qualified R&D people left from the erstwhile pool of specialized small arms expertise which had been destroyed forever. To this day, US small arms R&D has not recovered from the loss of Springfield Armory.

A Last Word on Ball Powder

Throughout the ball powder controversy Olin insisted that no improvements could be made to their proprietary propellant WC846, as it was already as good as they could make it. As we have seen, in answer to an allegation made in the October 1967 Ichord report, Olin immediately and emphatically disassociated itself from any share of blame or culpability in the selection and use of ball powder in the 5.56mm program.

Here too, however, as with the rifle, events had indirectly served to selectively modify ball powder, to the occasional detriment of the rifle/ammunition system as a whole. Speaking once again from Frankford Arsenal, Bill Davis explains some curiously variable results which Colt's had recorded over the years when testing rifles with different lots of ball-powder cartridges:

Sixteenth Memo Report on M16A1 (AR-15) Rifle/Ammunition System

Change in Nomenclature for Ball Propellant Used in 5.56mm Ammunition

10 February 1970

Ball propellant approved for use in 5.56mm ammunition since April 1964 has been identified as WC846 and has been produced in accordance with Drawing #B10534784..[It] has also been used for even a longer period of time in the loading of 7.62mm cartridges. Producers..however, have been "tailoring" this type propellant..to assure compliance with the ballistic requirements of the specific type and family of cartridges involved. Subtle changes in tolerances of percent deterrent and in grain geometry have been implemented over the years to allow..sufficient latitude to produce WC846 for both 7.62mm and 5.56mm cartridges within the limits of the same drawing. In effect, WC846..produced for 5.56mm.. constituted that fraction of propellant at one end of the drawing tolerance limit and WC846 "tailored" for 7.62mm.. was confined somewhat to the chemical and physical characteristics of the opposite end of the tolerance limit.

Occasionally, cartridge producers, to accommodate changes in production schedules, would interchange these two subtly different WC846 propellants and load or attempt to load a type or caliber of cartridge for which the propellant lot was not specifically "tailored" or tested by the propellant producer. These activities frequently resulted in marginal cartridge ballistic performance and even, on some occasions, ballistic failures..

In 1969, a major investigation into the causes of M16 rifle gas-tube fouling was concluded [chapter 16]. The major cause of gas-tube fouling was found to be the presence of excessive amounts of residual calcium carbonate, a constituent of WC846..left over from an acid-neutralization step in the manufacturing process. The recommended solution.. was to reduce the permissible..level from 1.0..to 0.25% maximum. This change was implemented..on 29 September 1969 and currently applies to WC846..whether it be "tailored" for 7.62mm or 5.56mm cartridge loading.

For the aforementioned reasons, Frankford Arsenal and Olin Corporation (sole producer/contractor for ball propellant) mutually agreed, during January 1970,..that ball propellant for 7.62mm cartridges should continue to be identified as WC846 and ball propellant "tailored" for 5.56mm cartridges should be given another designation (WC844)..

294. *Above: the AAI XM19 serial flechette rifle (SFR), with new 50-round box magazine. Caliber 5.6x57mm XM645 (fig. 218 no. 3). This 1969 contract was the first award of an official "XM" number to a SPIW candidate.*

Below: M16A1 rifle with 20-round magazine. By this time the M16A1 was Standard 'A' for US troops everywhere in the world except the European theater.
Courtesy AAI Corporation

Whatever other problems attended the SPIW it was a fact of physics that firing a 10-grain flechette, instead of a heavier bullet, produced far less recoil impulse and hence less dispersion in the critical mean spread *of a 3-round burst. Investigations into rifle design parameters by the Human Engineering Labs (HEL) yielded the following interesting comparison of the typical recoil impulse of several standard weapons:*

7.62 NATO M14: 2.65 lb. sec.
.30 M2 Carbine: 1.18 lb. sec.
5.56mm M16 (with muzzle brake): 1.16 lb. sec.
4.32mm M16: 0.84 lb. sec.
AAI SPIW (no muzzle brake): 0.65 lb. sec.
AAI SPIW (with muzzle brake): 0.39 lb. sec.

Chapter Twenty

THROUGH A GLASS DARKLY

The Fate of the TCC and the PMR

With the TDP in hand the "bugs" were exorcised once and for all from the M16A1's tolerancing drawings. With second-source contracts in place to prove the point, production of the M16A1 soon ceased to be a viewed as a developmental project. In a first move toward recognition of this change in status, the benighted Technical Coordinating Committee (TCC) was dissolved on August 27, 1968.

By the end of the year, definitized contracts were in place at Colt's, Hydramatic and H&R. On 2 January 1969 the Project Manager's Office announced the acceptance of the first second-source deliveries: GM, 356 rifles; H&R, 107. As noted, the XM177E2 had been "reoriented" into what soon became oblivion, and the requirement for its production had been deleted from both second-source contracts at Col. Isaacs' suggestion.

..The rifle program encompasses the..M16 rifle family of weapons; XM203 grenade launcher components; and ammunition peculiar to these weapons systems until type classified "A". After the ammunition is type classified "A",

By the middle of 1969 a plan to disestablish the Office of the Project Manager had been drawn up, whereunder the "residual" staff of 26 civilians (down from a high of 43), ten officers and two enlisted men were to be redistributed within WECOM. In November 1969, Lt. Col. Rex Wing succeeded Col. Isaacs in a job that itself had only a short time to run. The first change was outwardly very subtle: the Office of the *Project* Manager, Rifles ceased to exist and in its place was created the Office of the *Product* Manager, Rifles.

At the same time it was tacitly admitted that since the demise of Springfield Armory, Rock Island's research and development capability had been less than adequate. Somewhat belatedly, it was also admitted that hitherto the PMR had had far too much on his plate. Thus, General Order number 82, signed in April 1970 by Major General Leo B. Jones, the Chief of Staff of the Army, spelled out Lt. Col. Wing's new mission as follows:

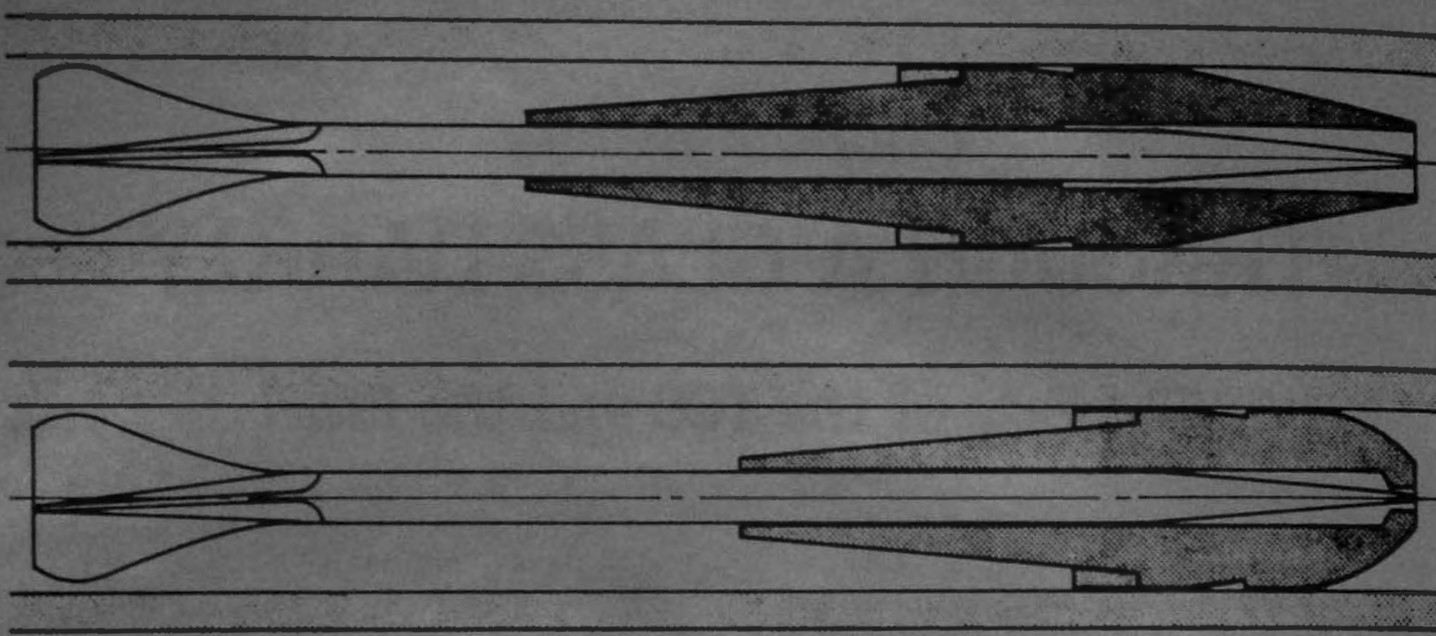
the Product Manager retains overall responsibility for gun/ammunition compatability and participates in and approves design changes in ammunition which affect military, technical or operational characteristics of the weapon systems..

Acronyms Ho: ARSAP; the FRP; and USASASA

Significantly, there was no longer any mention of the SPIW or any other "drawing-board" concept as part of Lt. Col. Wing's responsibilities. In August 1968 the Army Chief of Staff had created a new R&D management agency called the US Army Small Arms Systems Agency (USASASA), headquartered at Aberdeen Proving Ground, to oversee these futuristic concepts. USASASA's mission was to take over all other "individual hand-held and crew-served ground weapons" up to .60 caliber, in the process assuming management authority of ARSAP, the Army Small Arms Program.

Formed in January 1968 by order of the Chief of Staff, ARSAP divided up ongoing projects into time-slots: immediate, interim, near-future and long-term. ARSAP's long-term portion was designated the Future Rifle Program. The AAI XM19 SPIW became the serial flechette rifle (SFR); only one of four main projects within USASASA's Future Rifle Program (FRP). The FRP also embraced the SBR, or serial bullet rifle, built by AAI in caliber .17 (4.32mm); and proposed by General Electric's Weapons Development Department (situated in a leased facility at the now-defunct Springfield Armory) as a resurrection of the second-generation Springfield SPIW. In addition, several other agencies, both civilian and military, conducted research programs under Defense Department R&D contracts into multiflechette and caseless cartridges.

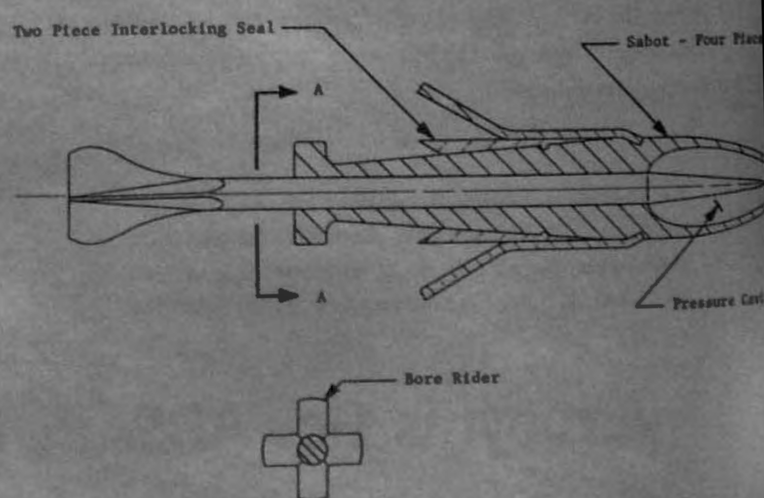
After an exemplary and cost-conscious tenure as Product Manager, Lt. Col. Wing was highly recommended for future challenges worthy of his managerial talents and, on 3 August 1971, the Office of Product Manager, M16 Series Rifles was discontinued by General Order number 229.



295. *Join If You Can't Beat 'Em Department: an interesting, 10-year "M16/ flechette" feasibility study for Frankford Arsenal by Colt's Technik Incorporated research division of Jericho, New York revealed that saboted flechettes, developed for smoothbore barrels, actually gave less dispersion from the M193 case (fig. 218 no. 6) when fired through regular rifled M16 barrels. As part of their February, 1971 report entitled "Flechettes Fired Through Rifled Barrels", Technik submitted a drawing of an improved sabot design (above, with standardized AAI design below) which gave even more impressive results.*

The Small Caliber Systems Program

By the mid-seventies USASASA's "overview" program had been renamed the Small Caliber Systems Program, within which the Future Rifle Program (FRP) was just one of many avenues of approach to the ideal personal weapon of the future. In the words of a 1975 briefing held at Frankford Arsenal, the ambitious Small Caliber Systems Program embraced "systems up to and including 15mm...hand guns, rifles, shotguns, grenade launchers, individual and crew served machine guns and sub-caliber training devices". Several of these interesting developments are discussed below. Many were short-lived, regardless of merit, for the urgent need for new and specialized weaponry collapsed with the end of US involvement with the Vietnam war in 1973.



296. *Not to be outdone, AAI later countered with a 1978 proposal for yet another "Improved Sabot Flechette Seal Assembly", to be made from injection-molded, glass-filled nylon, which AAI claimed would do away with the SPIW's problematical sabot "stripper" and provide positive separation by "ram-air pressure" as air entered the pressure cavity shown. Not adopted.*
Courtesy AAI Corporation

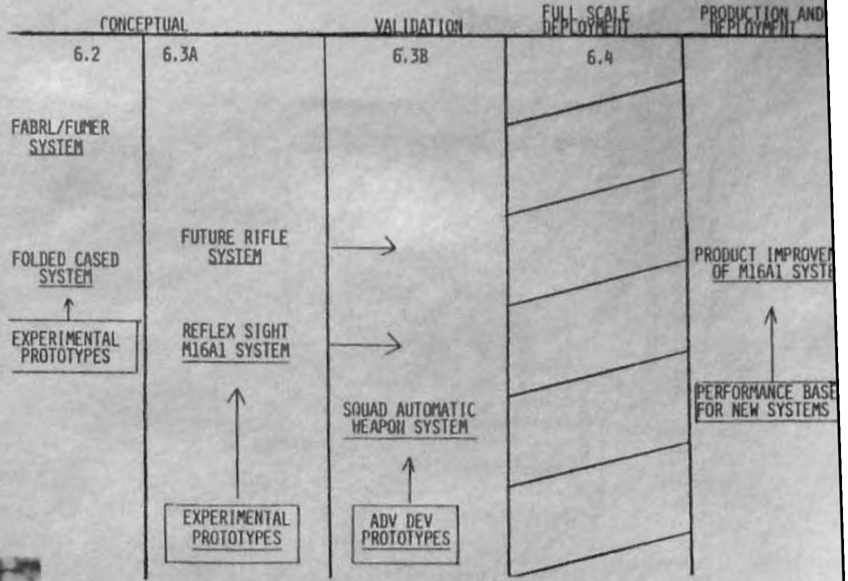
Reflex Sight for Small Arms Weapons

A Frankford Arsenal M16 sight enhancement program was begun in 1967 as US troops in Vietnam stressed the need for a sight which, in the words of a status report presented at the mentioned 1975 Aberdeen briefing, "enabled [the user] to engage targets under twilight conditions, (dawn/dusk), where he could see the target but could not see his sights".

By 1975, Frankford reported that of an original field of some sixty sight systems evaluated, five concepts were tested further and of these, two had emerged which offered "significant improvements". The first of these attached to the rifle's standard iron sights and provided a larger or highlighted rear aperture and a front blade or dot painted with a self-illumunating drop

of promethium. The second was the reflex sight, a "lightweight, optical sight without magnification (unity power), that offers an increase in hit probability and a decrease in response time to engage a target."

The unit-power reflex sight idea was certainly not new: the bullpup British EM-1 and EM-2 rifles were so fitted back in the late nineteen forties. The main advantage of such a sighting system as Frankford saw it was that "..improved performance is due to simplicity in aiming small arms with a reflex sight. When the target is viewed through the sight, alignment of the aiming point [reticle pattern] in the sight and the target is all that is required".



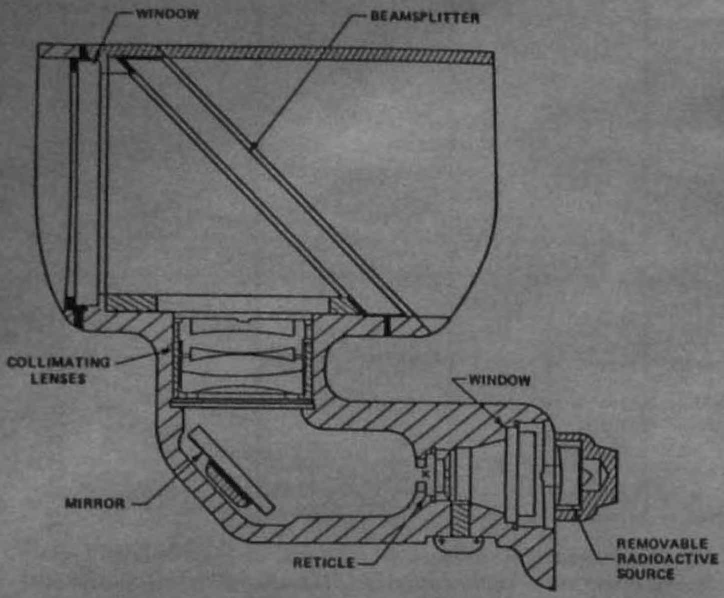
297. This diagram of the "System Acquisition Cycle" for the Small Caliber Systems Program was presented to the "DOD Gun Panel" as part of a Frankford Arsenal briefing on March 5, 1975. showing. The "identification and advancement of new technologies" was to be accomplished under the conceptual (6.2) program element, with more advanced concepts moving through the range of elements to full-scale deployment.

298. One of the sixty-odd sighting systems evaluated in the Frankford Arsenal sight enhancement project of 1967-75. The British "Singlepoint" sight was originally developed in 1968 for UK trial on L1A1 rifles. Not a true see-through sight, the Singlepoint offered improved target acquisition and hit capability by projecting a bright red aiming dot onto the target, which was viewed with both eyes open.

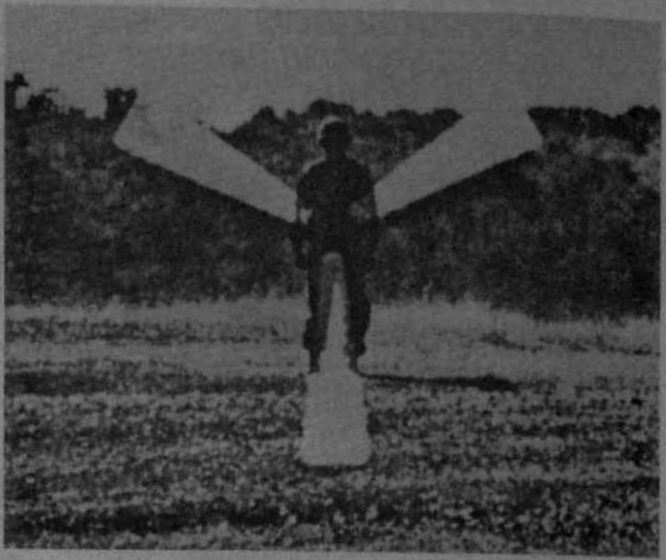
299. Another sight system evaluated at Frankford, called the Rickert sight. Like the civilian Nydar shotgun sight, this presented a reflected reticle on a ground-glass screen.

300. The Oxford "sight and gyro stabilizer", still another device tested in the early stages of the Frankford Arsenal sight enhancement program.

301. Designed by Robert E. Snodgrass, who also built and tested the "Product Improved" M14 prototypes at Rock Island Arsenal (US Rifle M14), these night sights were fully adjustable for windage and elevation, with a 3/8" rear aperture and a 3/4" front aiming tube.



302. A diagram of the Reflex Collimator Sight (RCS), developed jointly by Frankford's Fire Control Laboratory and AAI Corporation. An example of a program falling into the "6.3 area" (the advanced conceptual program element) of Frankford's Systems Acquisition Cycle (fig. 297). The Infantry Board conducted a six-month trial of 25 improved RCS models in mid-1975, wherein 28 rifles fired 66,230 rounds of ammunition. The RCS was not adopted.



303. The final RCS reticle design, which was projected as an illuminated, inverted yellow "Y" onto the target. Not adopted.

The report continued with the history of Frankford's reflex sight project:

Six (6) prototype reflex sights were fabricated in-house and submitted for MPT at Fort Benning, GA. Tests were completed in May 1973 and results showed significant improvements in Ph [hit probability] with the reflex sight over the standard iron and promethium sights. Ph increases on the order of 30% were obtained and as high as 50%...Noted during these tests was the fact that all shooters could use the same zero setting on the sight as opposed to individual settings required for iron sights.

In addition, the zero setting of the reflex sight did not move during the entire four (4) months of firing tests.

Based on user recommendations resulting from the MPT, variations of the reticle patterns were designed. Additionally, three beam splitter colors were selected ...The final configuration of the reticle pattern is the inverted Y [fig. 303] and the color chosen was yellow..

The report ended by noting that tests of 25 new reflex sights featuring the finalized yellow reticle were still ongoing at Frankford and Fort Benning, but to date it appears that the project has made no further progress.

304. An example of blending the fruits of two programs together in the search for enhanced hit probability (Ph). Here a reflex collimator sight (RCS) is mounted on a modifed M16A1, rebarreled to fire the "full bore" Frankford Arsenal 4.32x45mm (.17 caliber) "micro-bullet" cartridge (fig. 306 no. 2). Note, from the front: the "cylindrical muzzle brake compensator" (fig. 305); the "bobbed" gas block and carrying handle; the reflex collimator sight (RCS) attached to the flat top of the receiver.

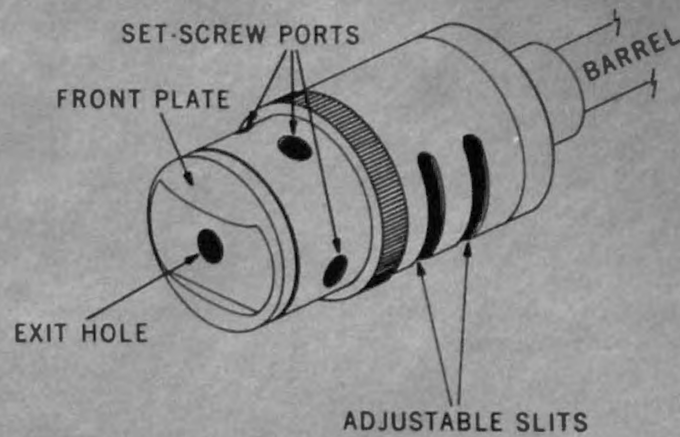
"Microbullet" Cartridge Developments - the 4.32mm XM16E1

The 4.32x45mm (.17 caliber) development was part and parcel of the mentioned serial bullet rifle (SBR) project. The SBR was essentially an attempt to equal or approach the low recoil impulse (and hence the lethally tight *mean burst spread*) of the SPIW, or serial flechette rifle (SFR), while doing away with the extremely expensive and sometimes erratic serial flechette cartridge.

In mid-1965, six specially modified XM16E1 rifles had been ordered from Colt's in support of an ongoing Ordnance evaluation of the 4.32x45mm cartridge. By this time, two basic "micro-bullet" approaches were being examined. The first, which could be fired from a regular 5.56mm M16, utilized the standard M193 case and a saboted 28-grain 4.32mm bullet (fig. 306 no. 3). The second or "fullbore" approach featured the same 4.32mm bullet in a necked-down 5.56mm case (fig. 306 no. 2) and was fired from a micro-bore barrel: hence the special 4.32mm XM16E1s from Colt's.

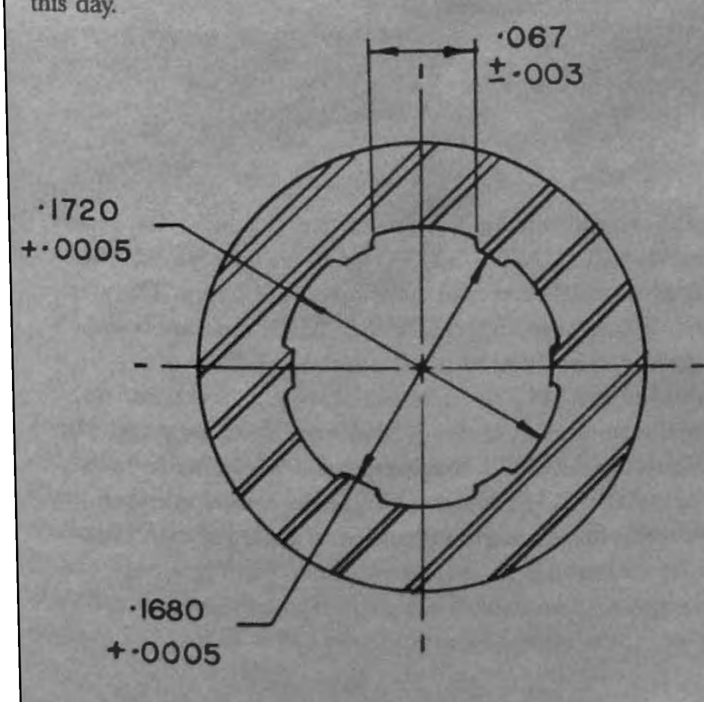
In order to learn as much as possible from the six-rifle test, the first two of the special XM16E1s were ordered with button-rifled 4.32mm barrels dimensioned in accordance with drawing FA32712 (fig. 307) and were equipped with Colt 2- or 3-shot burst control devices. The next two had the same barrels but no burst control capability, while the final two were needed to support a micro-bore chrome-plating investigation at Springfield Armory, and were ordered with slightly oversized barrels and a supply of rifled-but-not-chambered blanks.

Severe barrel erosion and bullet disintegration dogged the 4.32mm project. In addition, a successful 4.32mm tracer bullet proved particulary elusive. Nevertheless, the considerable theoretical advantages of a bulleted, burst-fire, low-recoil-impulse weapon have kept the micro-bore idea alive and viable to this day.

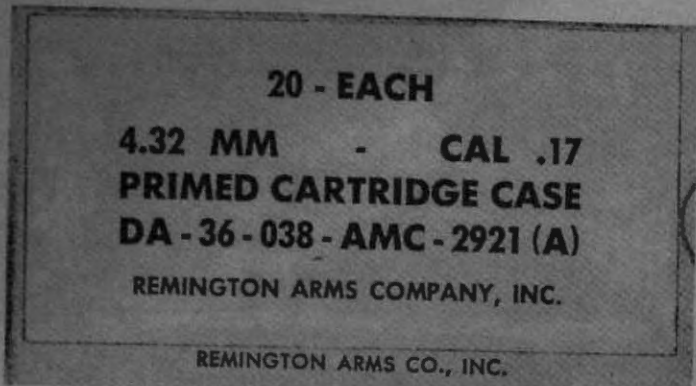


305. The HEL experimental "cylindrical muzzle brake compensator" developed to produce the lowest possible recoil signature from the 28-grain, 4.32mm bullet.

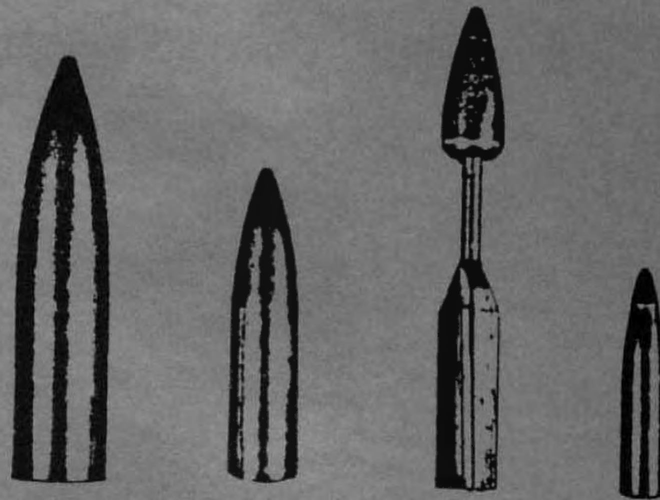
306. Further (actual size) cartridge development. All but no. 5 are based on the standard 5.56mm (M193) cartridge case. From left: 1. one of several types of 3.5mm micro-bullet designs from Fabrique Nationale, headstamped FN 73; 2. Frankford Arsenal 4.32x45.6mm (caliber .17) "full bore" ball, headstamped FA 73; 3. the "saboted .17", which was designed to offer the .17's specialized, lower recoil signature (fig. 294) interchangeably with regular 5.56mm loads in standard M16s, headstamped LC 72; 4. UK 4.85x49mm tracer (red tip), headstamped RG [Radway Green] 77 485; 5. the 6x44.5mm XM732, one of several experimental cartridges developed for the SAW program, with olive-green lacquered steel case headstamped FA 73. *Author's collection*



307. Frankford Arsenal drawing no. FA32712 dated August 18, 1965, entitled "Rifling for Cal. 17 Weapon". 6-groove rifling, right hand twist; one turn in 8". This program was plagued with severe barrel erosion and loss of bullet "integrity". *Redrawn by Thomas B. Dugelby*



308. Labelled 20-round box of primed 4.32mm cases, made up by Remington for Frankford Arsenal under AMC contract. *Courtesy James Alley*



309. Frankford Arsenal display card from a 1967 project investigating incendiary bullet loads. From left: 1. cal. .30 (9-grain incendiary charge); 2. 5.56mm (3-grain charge); 3. SPIW flechette (1-grain charge); 4.32mm (1-grain charge).

The AAI XM70 and the Serial Bullet Rifle (SBR) Project

310. The SPIW's "last gasp": the no-frills AAI XM70. Only one prototype was submitted, in May of 1974. The XM70 fired the XM645 flechette cartridge from an open bolt position, full auto or 3-round burst fire only. Note the reflex collimator sight and 30-round box magazine.

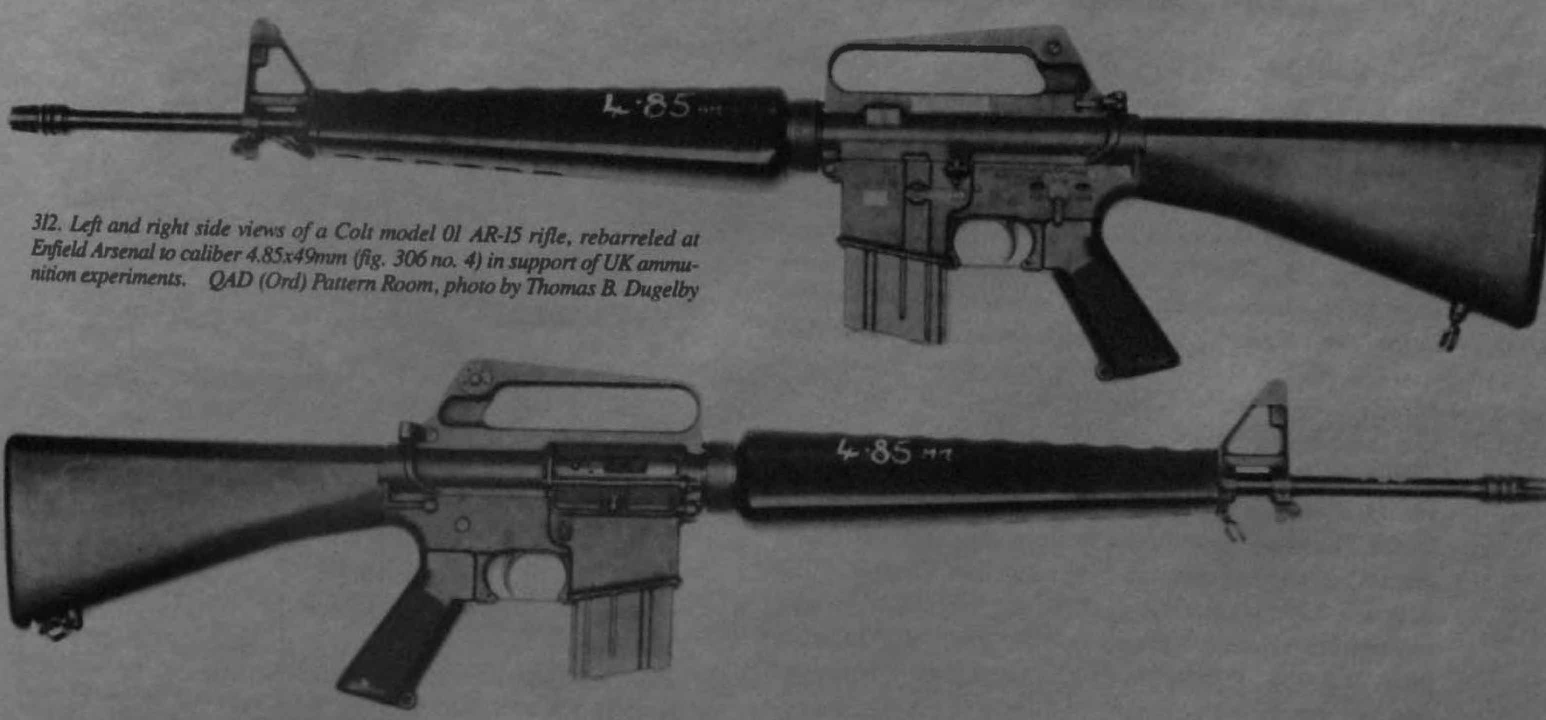
As discussed in *The SPIW,* the AAI XM70 was a one-off, last-ditch effort to revive the flagging SPIW program with a "simplified serial-fire rifle". The XM70 fired the AAI XM645 flechette cartridge from an open bolt only, in either a semi-auto or three-round burst mode.

In October 1974 the only XM70 ever built was shot, alongside two of the modified 4.32mm XM16E1s, in a "Dispersion Versus Cyclic Rate" test sponsored by the Army's Human Engineering Labs (HEL) at Aberdeen. While the XM70 turned in a respectable impulse level when tested with HEL's special dispersion-minimizing muzzle device (fig 305), the report noted that the XM70 "was found to be unserviceable after six trigger pulls [burst fire] per subject at 800 rpm. Therefore, all the 800 rpm modified SPIW [XM70] data are based on six pulls rather than 10 in all other cases.."

With the demise of the XM645 serial flechette cartridge the short-lived XM70 was superseded by the 4.32mm AAI serial bullet rifle (SBR), itself a fleeting development on the way to the firms' current, multi-level involvement in future rifle concepts.

311. *The partially-stripped, 4.32mm prototype of the AAI serial bullet rifle (SBR), first unveiled at a Fort Benning conference in May of 1977. The 10-lb., clip-fed AAI SBR featured a unique, two-mode firing system (semi auto and 3-round burst only) wherein the firing pin was hammer-actuated for semi auto fire and the first round of a burst, but the firing pin was locked open (fixed firing pin) for rounds two and three of the burst. Note the reflex collimator sight and sturdy, time-proven gas piston/operating rod.*

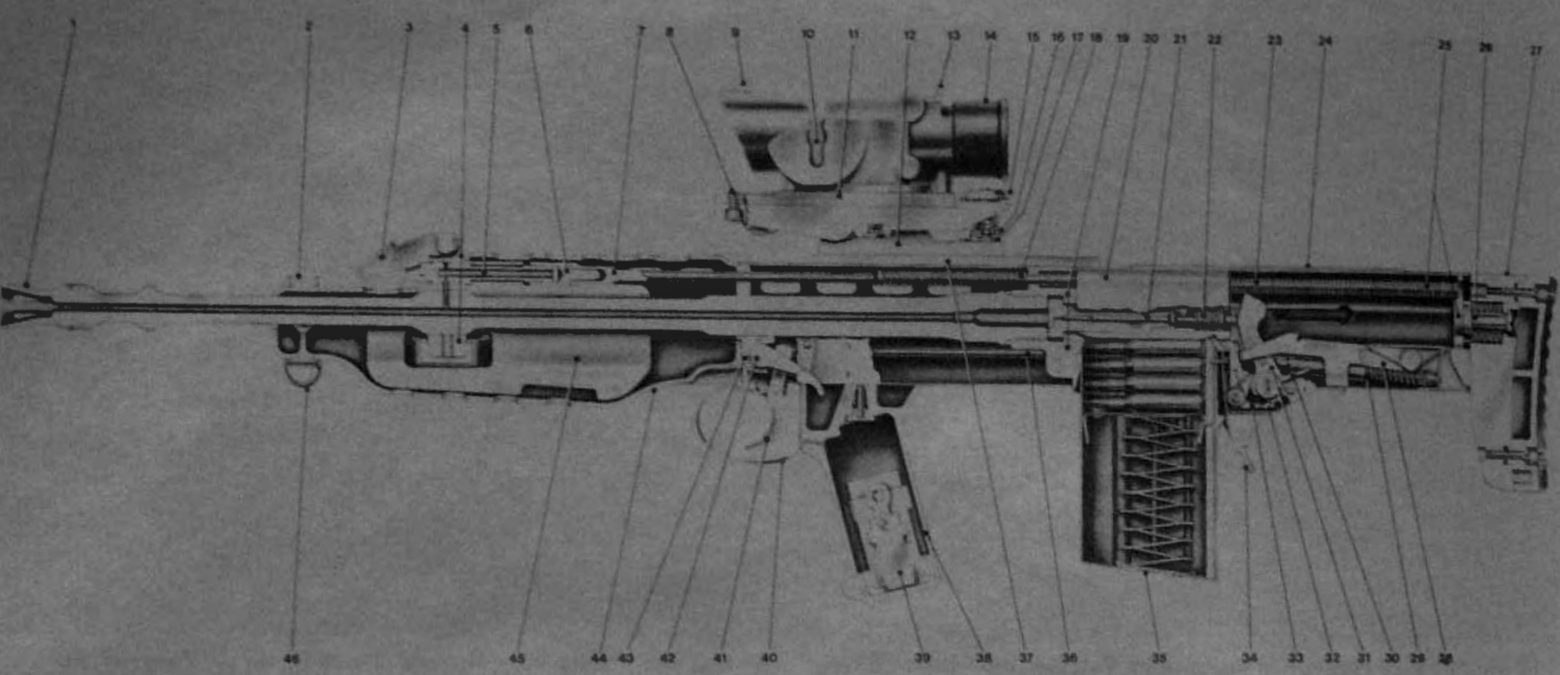
The AR-15 in UK Caliber 4.85x49mm



312. *Left and right side views of a Colt model 01 AR-15 rifle, rebarreled at Enfield Arsenal to caliber 4.85x49mm (fig. 306 no. 4) in support of UK ammunition experiments. QAD (Ord) Pattern Room, photo by Thomas B. Dugelby*

As discussed at length in Collector Grade's *Modern Military Bullpup Rifles*, a late-sixties British cartridge enhancement program had led to the development of a unique UK 4.85x 49mm infantry round. Both a selective-fire AR-15 and a Stoner 63 belt-fed light machine gun were converted at Enfield Arsenal to fire 4.85mm ammunition, in initial support of a program designed to replace the British Army's ageing 7.62mm L1A1 rifles with a new bullpup 4.85mm Individual and Light Support Weapon (IW/LSW) system.

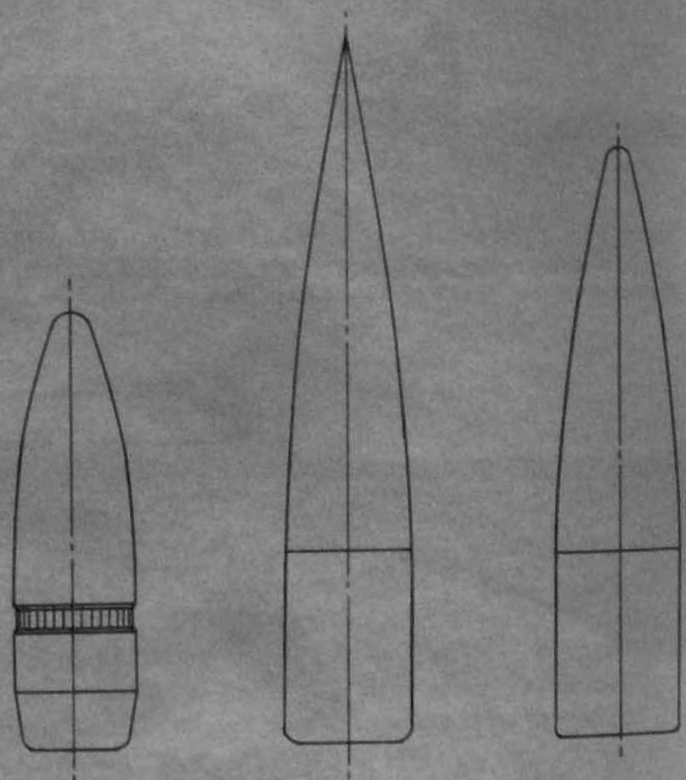
This and other unilateral programs within the NATO alliance threatened the hard-won concept of cartridge standardization, and led to the "Weapons for the Eighties" NATO trials in 1978-79 (chapter 22). These in turn confirmed the FN SS109 version of the 5.56x45mm as the second NATO caliber, and put an end to UK 4.85mm development.



313. *Fig. 1 from a British Army manual dated November 1976, entitled "Individual Weapon - Sectional Arrangement". Caliber 4.85mm. Both left- (XL68E2) and right-hand ejection (XL64E5) models were made. These UK bullpups were derived from the ArmaLite AR-18, and feature gas impingement operation of an 8-lug bolt-and-carrier system. Note the emergency iron sights (nos. 9 and 13) on top of the excellent Sight Unit Small Arms Trilux (SUSAT) optic sight (discussed in* Modern Military Bullpup Rifles*).*

The FABRL Von Karman Bullet and the "Fumer" System

Along with the reflex sight, the other concept being studied circa FY75 under "identification and advancement of new technologies" (area 6.2, fig. 297) was a joint Frankford Arsenal/BRL investigation of the *long-range* role of enhanced 5.56mm weapons. A 2-phase plan began with a BRL compendium of projectile shapes, from which was selected the "AR2 artillery shape [fig. 314, center] scaled down to 5.56mm". The sharp point was too hard to manufacture, so a compromise resulted in the "Von Karman" bullet which approximated the drag characteristics of the AR2 but was one caliber shorter with a blunter point. It was determined that 15 grains of propellant, launching the 32-grain Von Karman bullet at 3,250 fps, would produce a trajectory identical to that of the 55-grain M193, yet would reduce the recoil impulse from 1.2 lb. sec. to 0.8 lb. sec. The smaller powder charge paved the way for an experimental, shorter aluminum case, and the 87-grain "low-impulse" 5.56mm cartridge was born (fig. 315). FABRL results indicated that this new concept would "offer a 60% improvement in average Pi [probability of incapacitation] between 0 and 500 meters".



314. *Left: standard 55-grain M193 bullet for comparison. Center: the AR2 artillery shape scaled down to 5.56mm. Right: the 32-grain Von Karman bullet.*

Redrawn by Thomas B. Dugelby

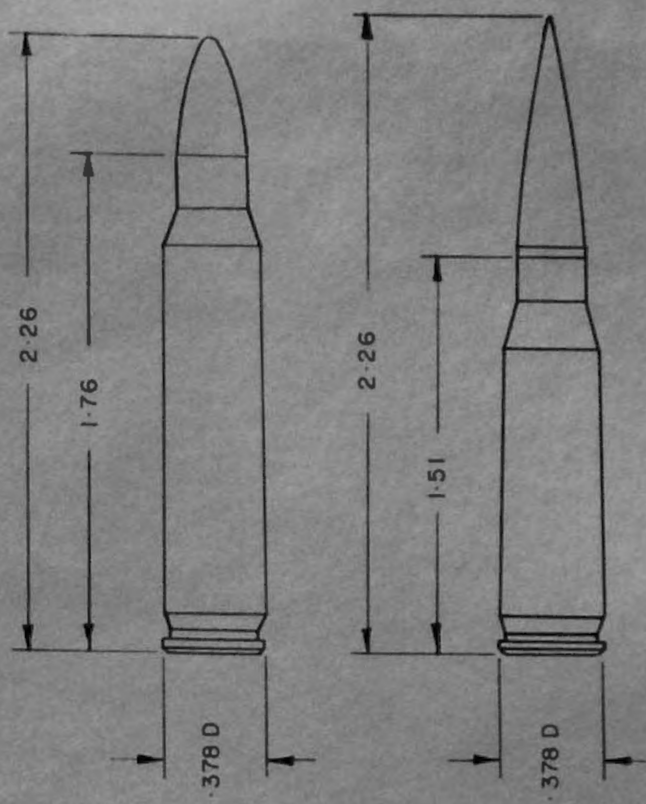
The second phase coupled "fumer" technology into the study. As the 1975 briefing to the "DOD Gun Panel" explained,

> *The fumer phenomenon is an approach to reducing projectile base drag by injecting heat and/or mass behind the base of the bullet...A projectile has three drag components; wave drag, skin drag, and base drag. The base drag is the result of a low pressure, "dead air region" behind the base of the bullet. The injection of heat and/or mass..increases the pressure and approaches an equilibrium state, thereby reducing the base drag component. This effect is similar, but more pronounced than that achieved with tracer ammunition.*

FABRL found that, even though the Von Karman bullet was "low drag", its base drag component was a significant 63% of the total. Calculations were that by adding fumer technology, the base drag of the Von Karman bullet could be reduced by 75%, thus *halving* the overall drag.

Robert J. McHugh of the Small Caliber Ammunition Division concluded the "DOD Gun Panel" briefing on this short-lived but interesting ammunition enhancement study with the following statement of results:

> *As a result of this analysis we have determined that a new machine gun system employing this 87 grain cartridge would offer effectiveness comparable with the M60 machine gun based on the SAW tactical scenarios. This fumer effect, applied in the rifle role, would further increase the effectiveness gain from 60% to 70%.*



315. Left: the standard 5.56mm M193 round. Total weight: 175 grains. Right: the proposed 87-grain FABRL "low-impulse" round.
Redrawn by Thomas B. Dugelby

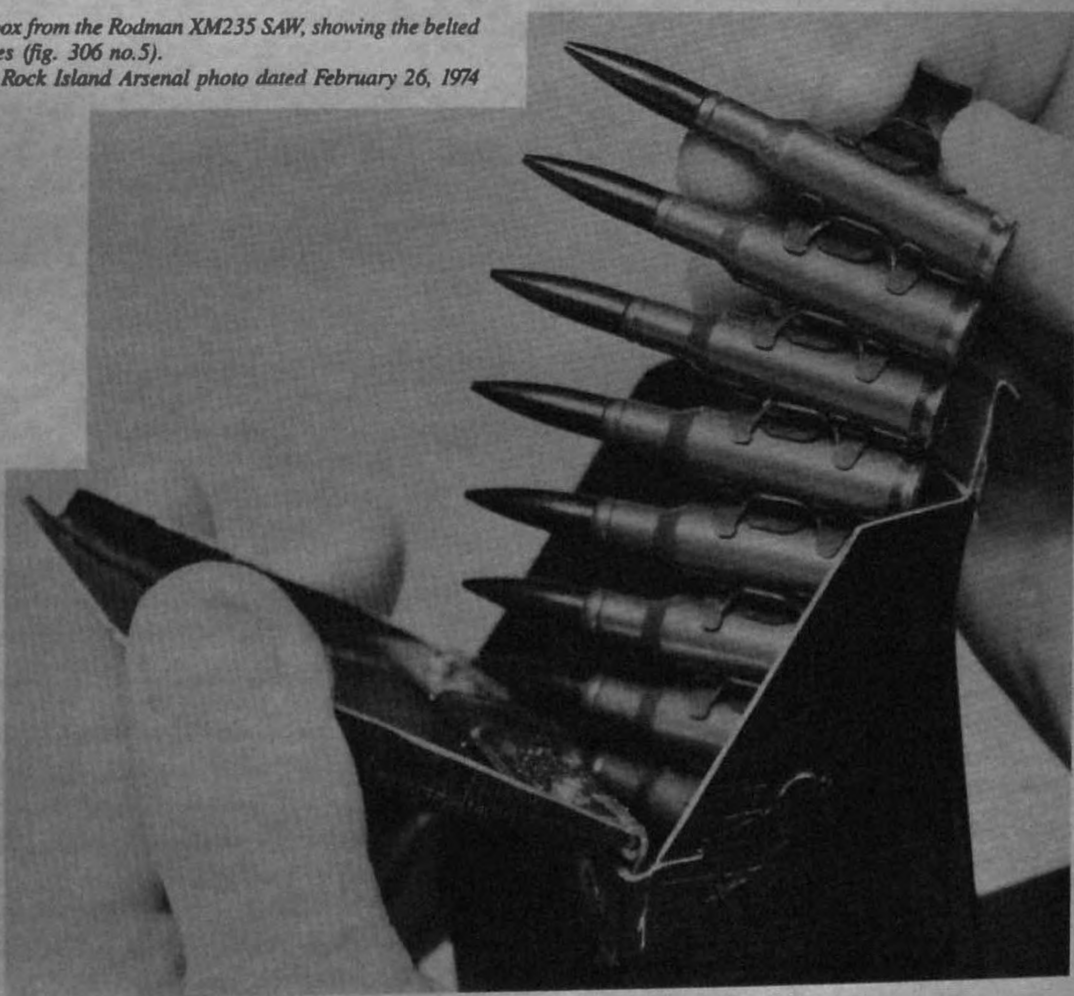
A Glimpse at the Squad Automatic Weapon (SAW) Program - the 6mm M16 and the XM106

316. A rare photo showing an M16A1 rifle converted to fire 6mm XM732 ammunition (fig. 306 no. 5) in support of the SAW program. Note the flash suppressor from the Rodman SAW, the XM235 (fig. 317) and the receiver and magazine, which have been cut in half and extended to accommodate the longer overall length of the XM732 round.
Rock Island Arsenal photo dated August 27, 1974

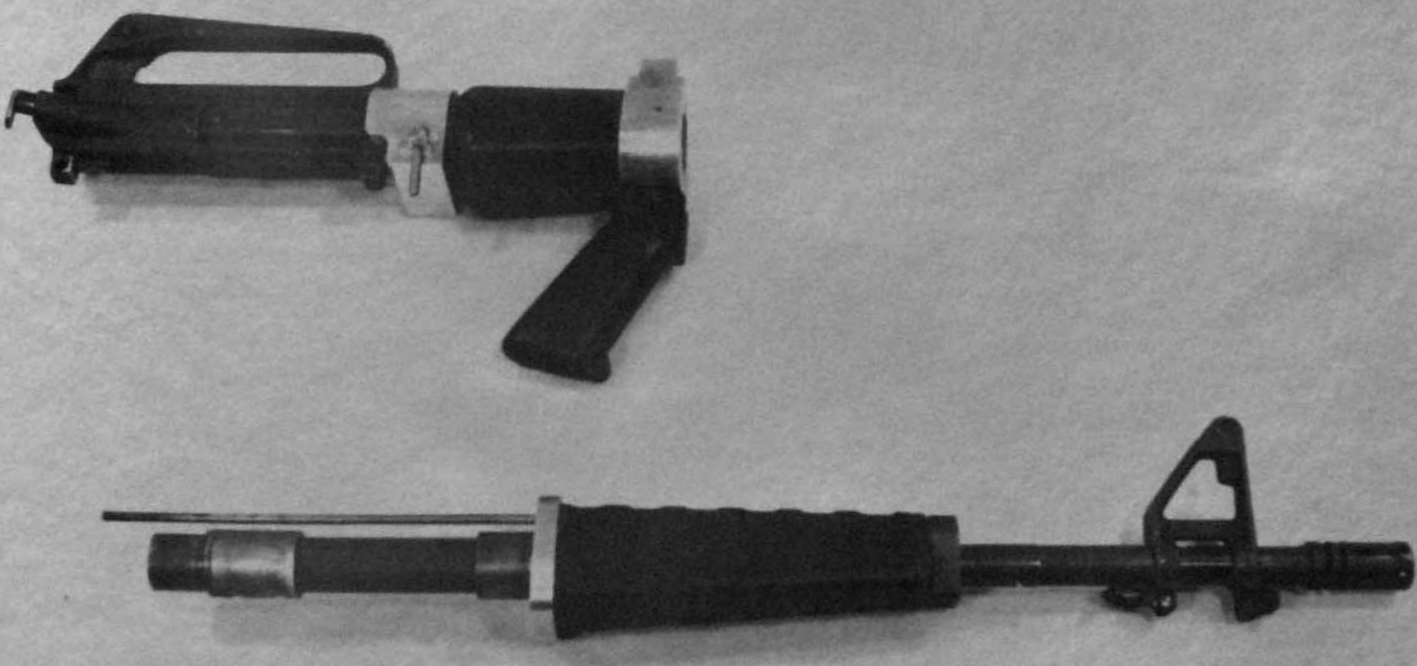
The mid-sixties Small Arms Weapons Systems (SAWS) study proved that the heavy-bullet 5.56mm loads being produced for Colt, Cadillac Gage (IWK), FN and others were capable of considerably enhanced long-range performance. When teamed with belt-fed weapons such as the Stoner 63A LMG or Colt's CMG-2, the results were sufficiently rewarding to launch a major new US investigation called the Squad Automatic Weapon (SAW) Program. While easily the subject of an entire book in itself, the SAW program yielded some interesting M16 versions worthy of brief notice here. The SAW program led to the adoption of the FN Minimi as the US M249 in 1982.

317. The story of the SAW program and its many extremely interesting weapon designs could fill a book as big as this one. This is a prototype of the XM235 machine gun, called the Rodman SAW as it was developed by the General Thomas J. Rodman Laboratory at Rock Island Arsenal. The receiver is marked "Gun Machine 6mm XM Rodman Labs SN 0005", and is essentially a stamped, sheet-metal shell: the Rodman's bolt assembly rides on dual, interchangeable top-and-bottom gas piston/guide rod systems. The 22.6-lb. XM235 fired belted 6mm ammunition from a 200-round ammunition box, shown behind the pistol grip.
Rock Island Arsenal photo dated December 3, 1973

318. The ammunition box from the Rodman XM235 SAW, showing the belted XM732 6mm cartridges (fig. 306 no.5).
Rock Island Arsenal photo dated February 26, 1974



319. The experimental XM106, another development of the SAW program. The short-lived XM106 was in response to a Marine requirement for extended-fire capability in the Colt M16 HBAR, and featured a quick-change barrel capability. *Photo courtesy Jean Huon*



320. Right hand view of the prototype of the XM106, showing barrel and upper receiver groups disassembled. Note the forward-mounted front sight, and the bipod mounting point above front pistol grip.

Gene Stoner Strikes Again - the ARES Future Assault Rifle Concept (FARC)

321. The ARES 5.56mm FARC-2 assault rifle. Note from front: muzzle brake/ compensator; folded bipod/handguard; automatic, spring-loaded dust cover; plastic 30-round magazine; reflex collimator sight.

A 1973 development contract to Gene Stoner's new firm, ARES Inc., of Port Clinton, Ohio, led to the design, development and fabrication of a "state-of-the-art" 5.56mm assault rifle called the "FARC-2". The prototype fired over 4,000 rounds during a test at Rock Island Arsenal in the summer of 1974, with encouraging results. ARES thereupon produced two prototypes of an improved version called the FARC-3 which was subsequently tested. Despite a number of novel features, the FARC fell victim to post-Vietnam war funding cuts and was discontinued in 1978.

322. US Army Armament Research & Development Command (ARRADCOM) trial of the improved ARES FARC-3, fitted with a metal Stoner 63A magazine. Compare with fig. 321: note how the operating rod handle cams the spring-loaded dust cover open with each shot.

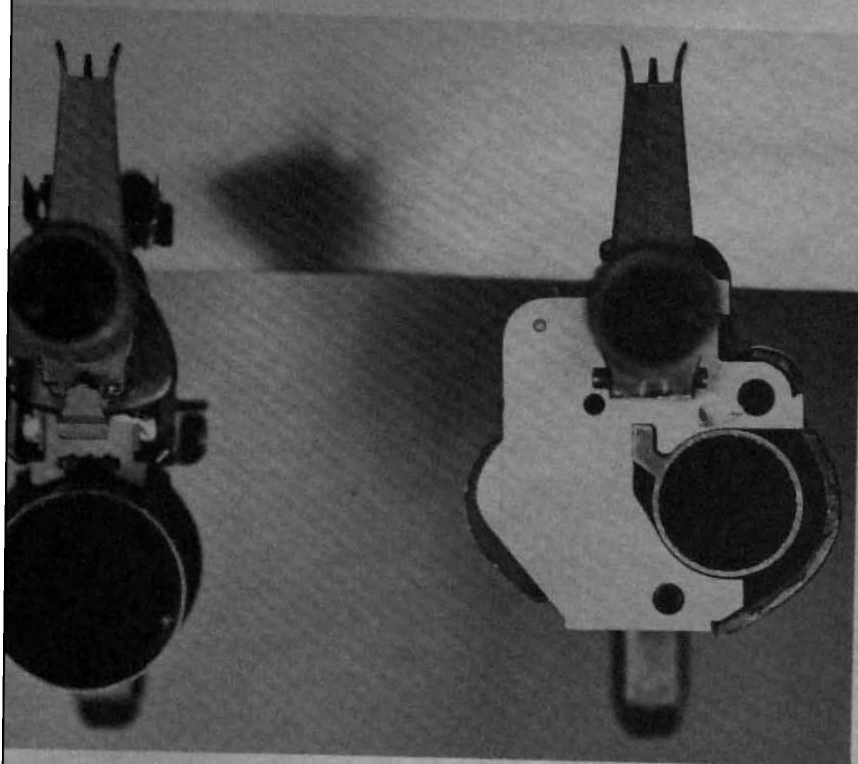
30mm Multishot Grenade Adapters

323. Comparison photo of 30mm and 40mm grenades. The short-lived 30mm program was an attempt to reduce the weight and bulk of grenades (and their launcher attachments) for the M16A1 and other weapons.
Rock Island Arsenal photo dated June 6, 1974

As we have seen, the idea of a grenade launcher/M16 combination led to the GLAD Program and the subsequent adoption of the single-shot, 40mm M203 (chapter 15). Meanwhile, one of the most persistent stumbling blocks throughout the SPIW program was that, in addition to 60 point-target flechettes, the SPIW was supposed to carry and launch *three* grenades, semi-automatically. Numerous attempts were made to "live with" this ludicrous requirement and a number of extremely ingenious designs were brought forth in the process, but the weight and girth of the standard M79-type 40mm grenade made a three-shot launcher attachment a virtual impossibility, especially from the "human engineering" standpoint.

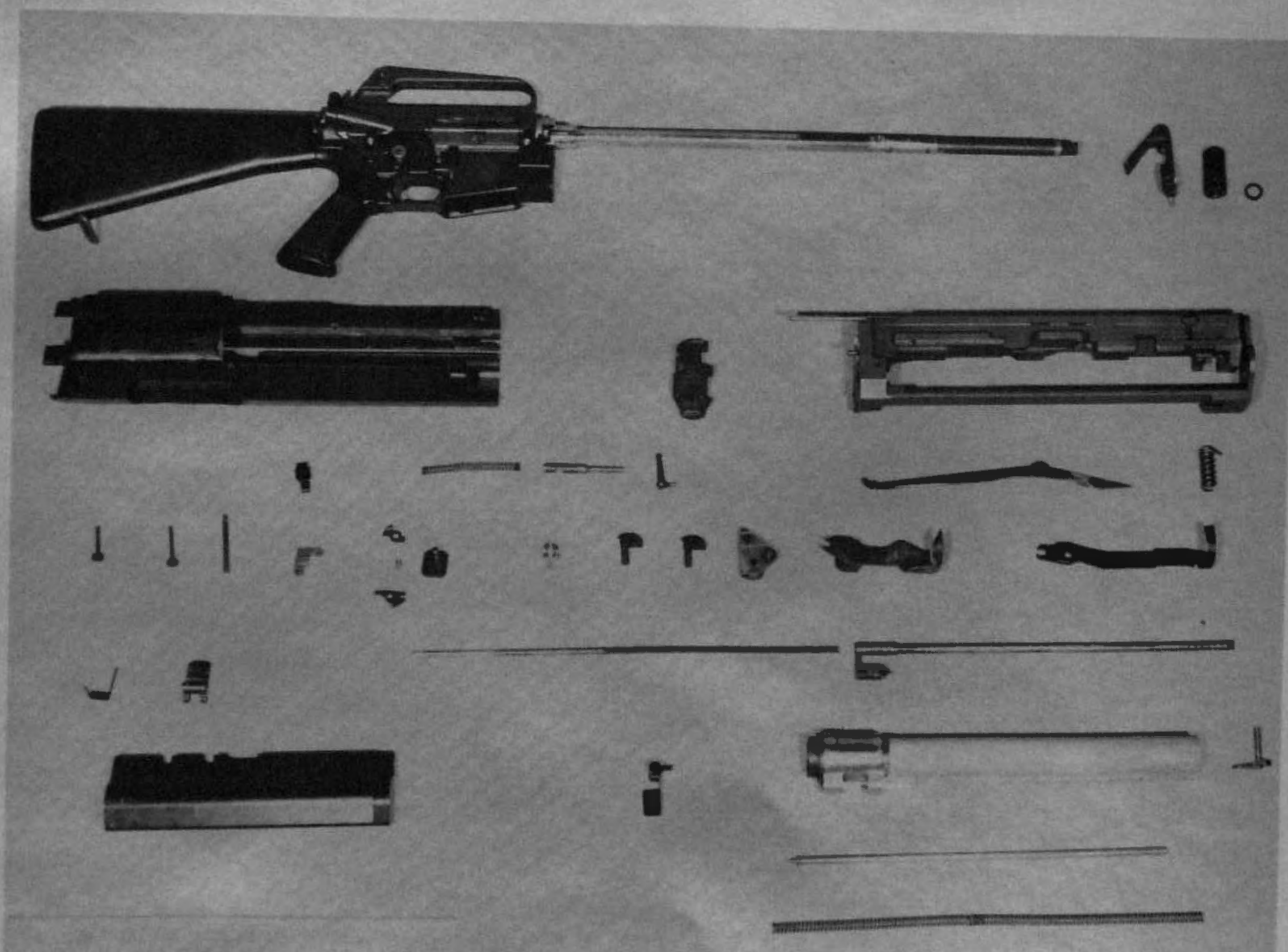
In 1972 the Army contracted with the Ordnance Division of the Honeywell Corporation of Hopkins, Minnesota, for the development of a smaller, 30mm grenade, which would permit the use of a more practical launcher. AAI, among others, produced a number of single-shot and semi-auto launcher attachments for the M16 and the XM19 SPIW.

324. Right side view of modified M16A1 rifle fitted with the HEL 30mm multishot grenade launcher prototype. Note the modified gas block, and the cross-bolt selector through the receiver. This allowed GL operation from the rifle's trigger.
Rock Island Arsenal photo dated April 6, 1976



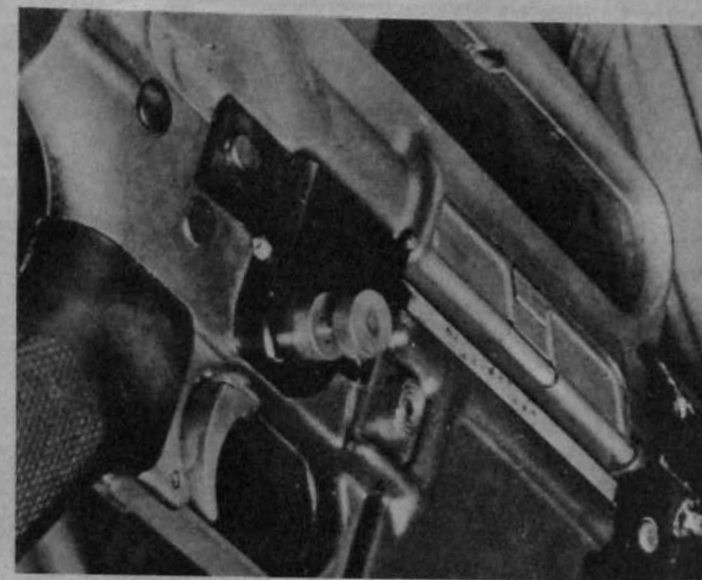
By 1978 the Human Engineering Labs (HEL) had also developed a 30mm multishot launcher, weighing 4.5 lbs., for attachment to the M16A1 rifle. A preliminary operation and maintenance manual was subsequently prepared, and the 12-lb. "package" was given a "user conceptual evaluation" by the Army Infantry Board (USAIB) at Fort Benning. The 30mm project was abandoned soon afterward.

325. A dramatic front view:
Left: standard M16A1 fitted with an M203 pump-action, single shot 40mm grenade launcher attachment.
Right: modified M16A1 fitted with HEL multishot 30mm GL prototype, serial no. 5. The blow-forward HEL device, tested as a prototype only, carried and launched four 30mm grenades semiautomatically.
Rock Island Arsenal photo dated April 27, 1976

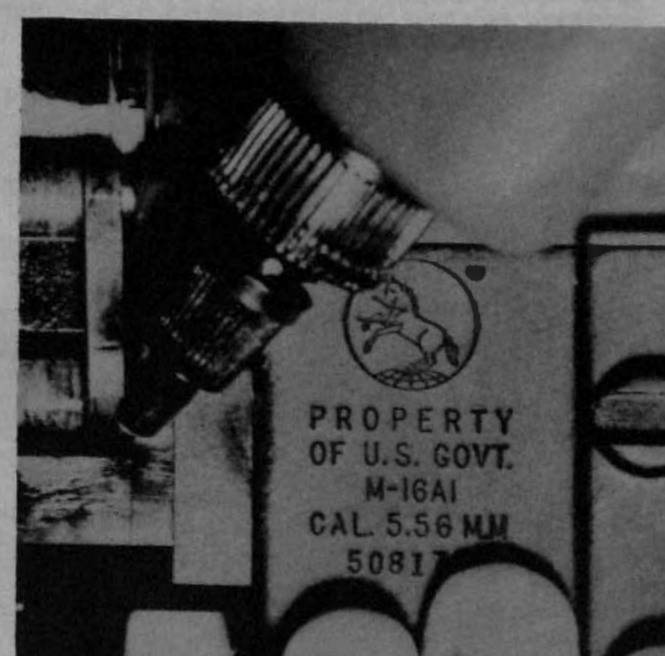


326. Fig. 2 from the Preliminary Operation and Maintenance manual for the blow-forward 30mm HEL multishot GL, entitled "Field-stripped view of GL". Note the turned-down rifle barrel. The manual identifies 22 dedicated GL components. Rock Island Arsenal photo dated February 18, 1977

327. Loading the four-shot HEL 30mm GL. Two rounds were first inserted in the (2-round) forward portion of the magazine, shown. Closing and latching the magazine automatically pushed one grenade back into the rear (1-round) magazine. Pushing the charging lever (of the blow-forward launcher) forward and allowing it to snap back chambered the rear round, and replaced it in the rear magazine with the round remaining in the forward magazine. The empty forward magazine was then recharged with two more rounds.



328. Right side view of cross-bolt selector in GL mode.

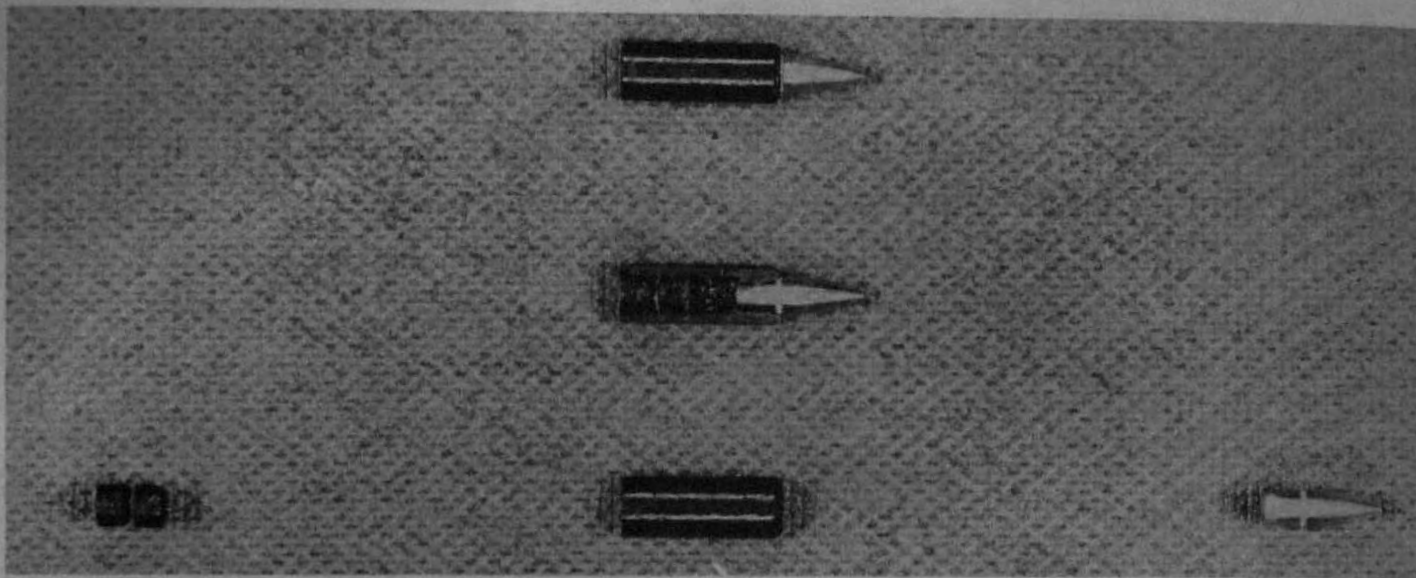


329. Oiling the firing pin and sear of the HEL 30mm GL. Note the rifle markings "M-16A1".

The AAI Caseless 5.56mm/4.32mm Advanced Combat Rifle (ACR)

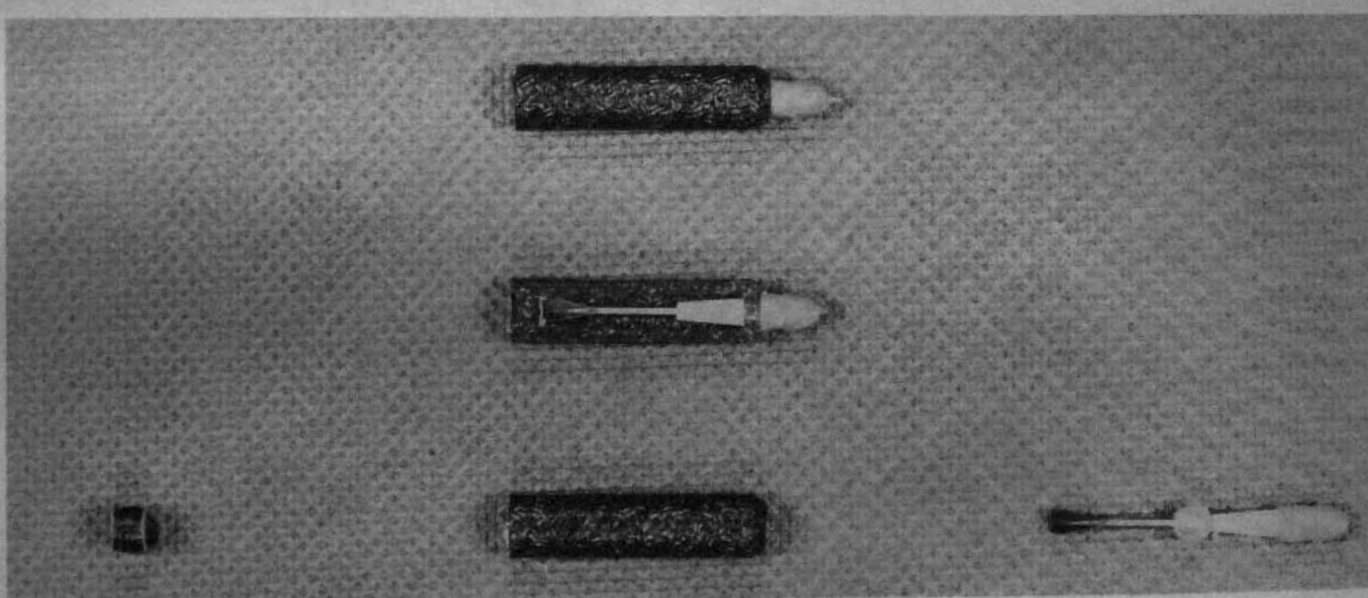
The innovative Heckler & Koch bullpup G11 rifle and its Dynamit Nobel 4.7x21mm caseless cartridge are discussed in *Modern Military Bullpup Rifles*. Even though cook-off and other problems caused the withdrawal of the G11 from the 1978-79 NATO trials, H&K persevered with the project. In September 1982 the US Army Research and Development Command (ARDC) Fire Control and Small Caliber Weapon System Lab at Dover, New Jersey awarded two 25-month contracts, one to H&K and the other to AAI Corporation, for the exploratory development of an Advanced Combat Rifle (ACR).

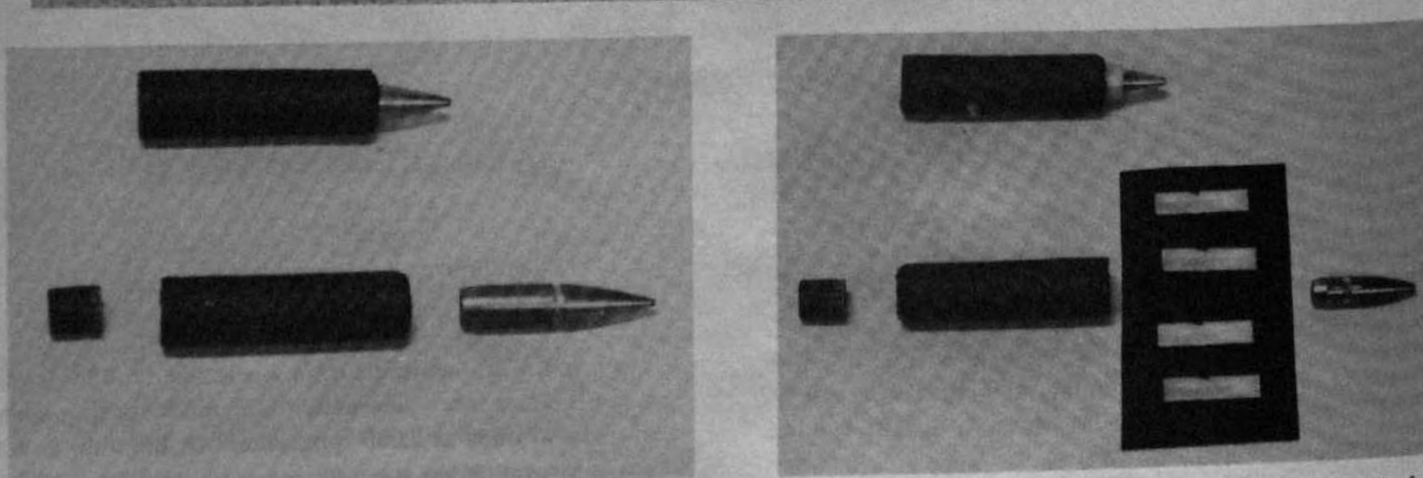
The AAI ACR featured a unique, gas-operated firing pin which produced three differently timed modes of fire: open-bolt 3-round burst at 2,000 rpm; open-bolt full auto at 600



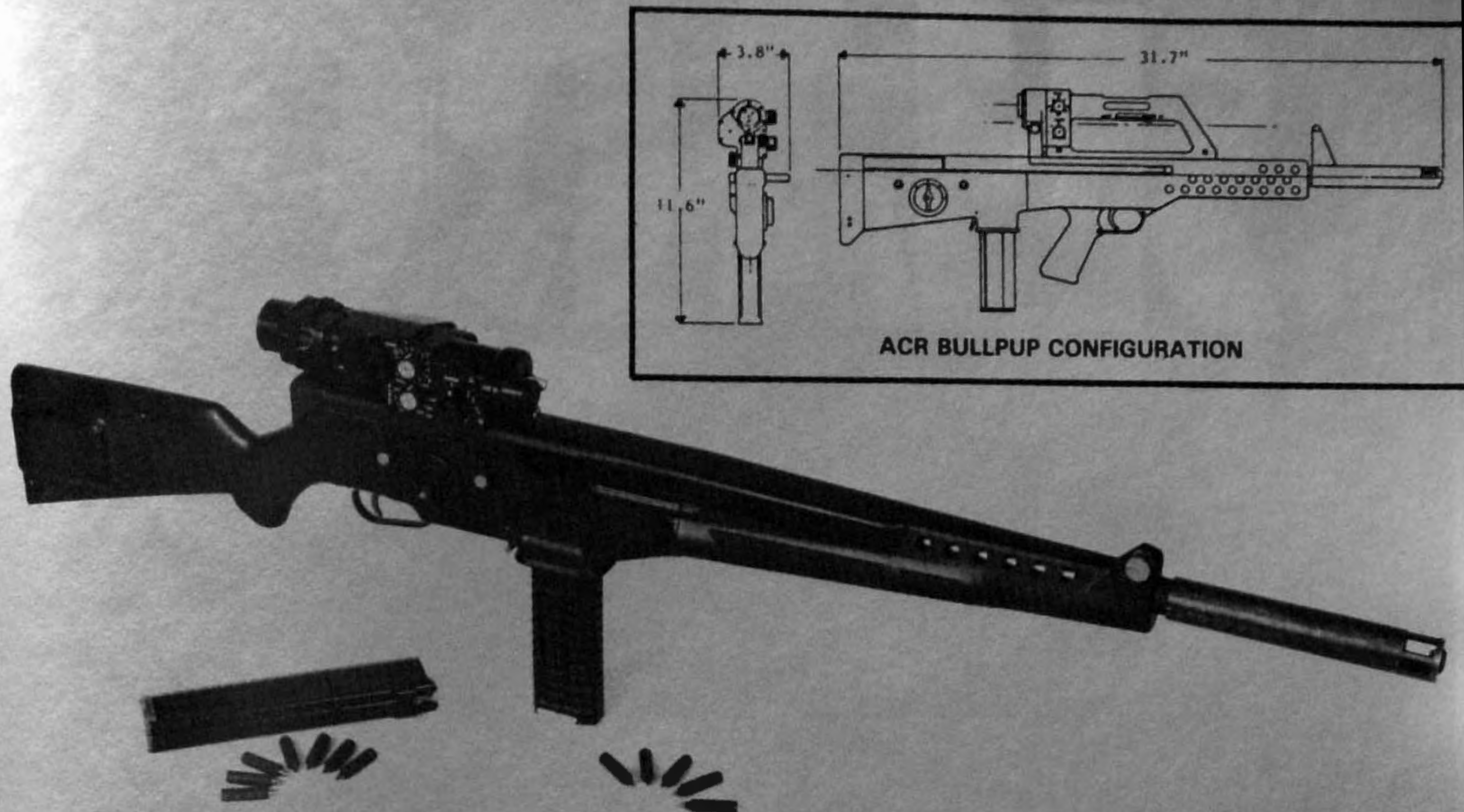
330. Frankford Arsenal cartridge display panels, circa 1969.
Above: three views of a double-primed, experimental 5.56mm caseless cartridge, 1.5" in length and weighing 82.5 grains, which produced the same muzzle velocity as the M193 (3,250 fps). Note, from the top: complete round; sectioned round; components of round (with two back-to-back primers). The caseless program was begun at Frankford in 1967.

Below: the same three views of a caseless SPIW cartridge, firing the standard saboted flechette. Due to the flechette's light weight (8-10 grains) the round only weighed 40 grains overall. The muzzle velocity is not listed, but if it were to approximate that of the "standard" XM19 SPIW round, the XM645, it would be around 4,800 fps.





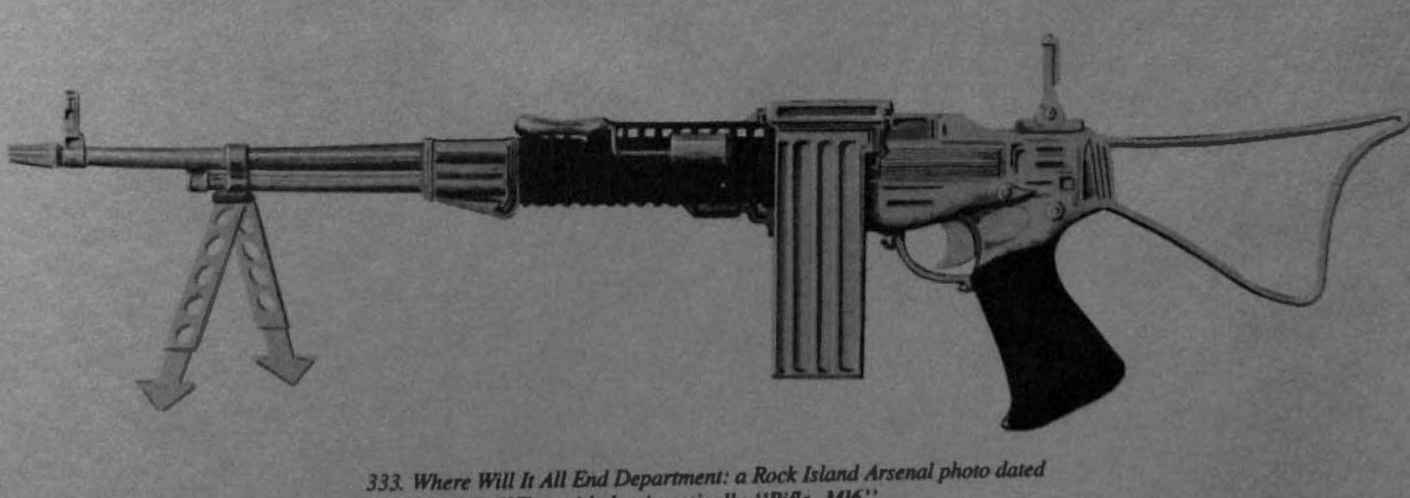
331. The two types of (interchangeable) caseless ammunition for the AAI ACR, showing complete and disassembled rounds. As the 4.32mm "sabot-bullet" leaves the 5.56mm bore, the gas-sealing sabot disintegrates into the four sections shown on the black card.



332. The AAI ACR, right side view, showing a few of the "heavy-bullet" 5.56mm loads (left) and some 4.32mm "sabot-bullet" rounds (right). The ACR drew heavily on experience gained during the XM19 and XM70 SPIW programs. Note the complex, tritium-illuminated "AAI Optical Sight with 3x Telescope Attached".
Inset: the proposed bullpup configuration of the AAI ACR.

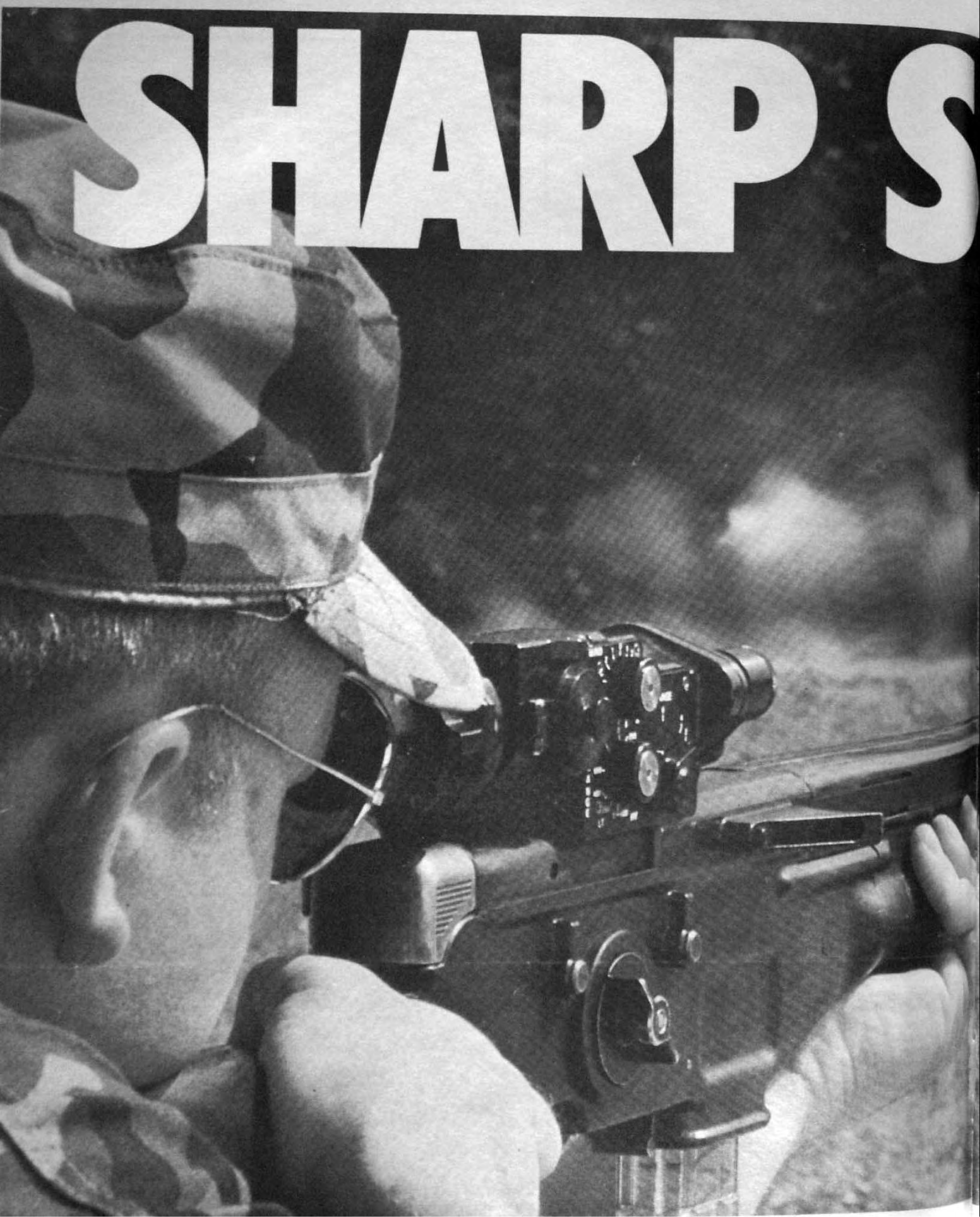
rpm; and closed-bolt semi-automatic. Like the G11, the AAI ACR was also built around a caseless cartridge, developed by the Hercules Powder Co. The AAI ACR fired either a full-bore 70-grain 5.56mm "heavy bullet" or a 28-grain saboted 4.32mm version, from disposable plastic magazines. To provide as much protection as possible for the compressed-powder cartridges, the 36-round magazines were factory pre-loaded and fitted with a cap seal, which was automatically broken and discarded by the action of inserting the magazine into the rifle. Both a 31.7-inch bullpup and a regular 7.9-lb. rifle version were offered, with AAI claiming "at least a 100% increase" in hit probability for their ACR over the M16, at ranges up to 600 meters.

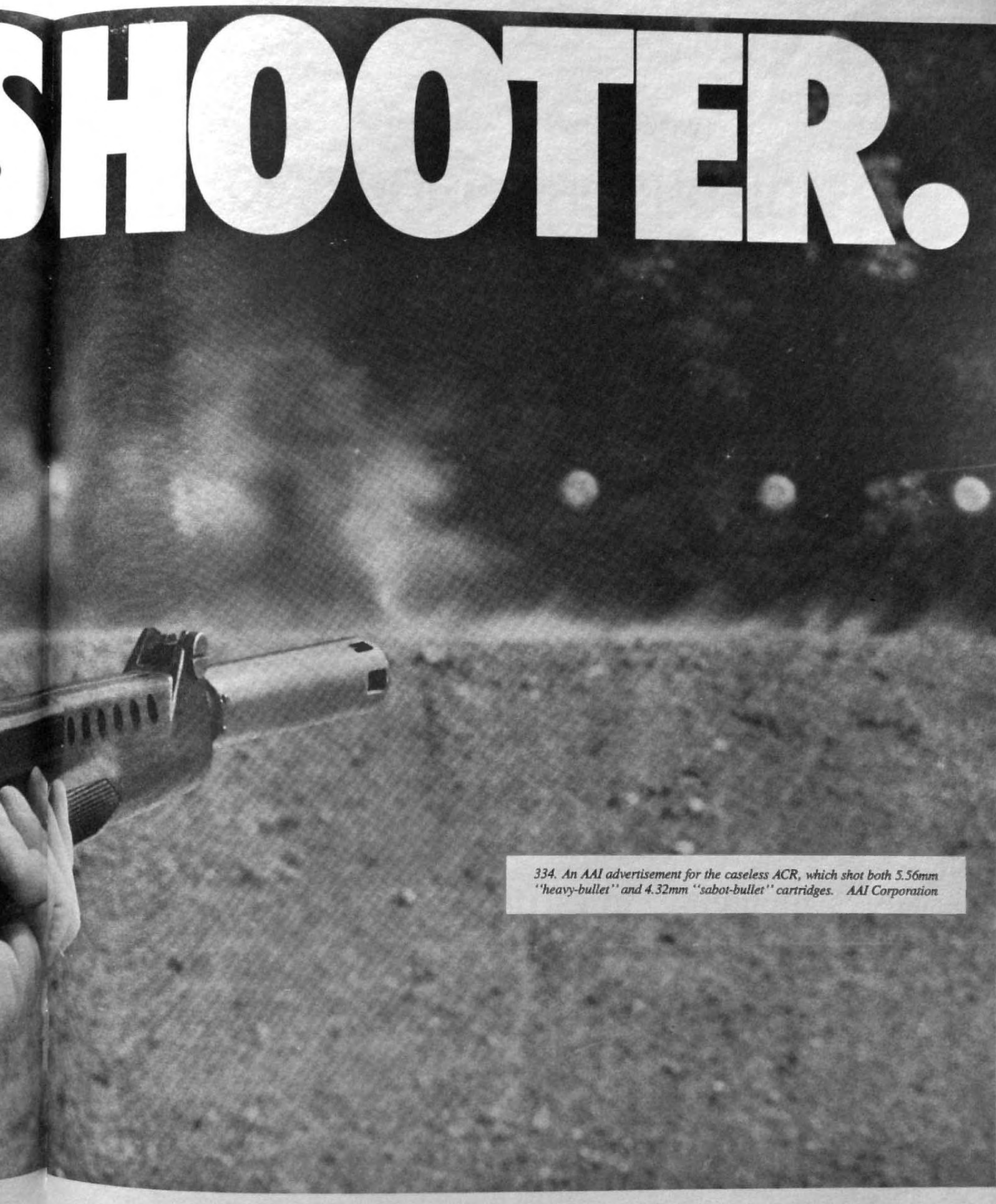
Testing and evaluation of these weapons and their later off-shoots, plus other investigations into every conceivable area of offensive and defensive military "interdiction", continues to this day.



333. Where Will It All End Department: a Rock Island Arsenal photo dated September 8, 1971, entitled enigmatically "Rifle, M16".

SHARP S





334. *An AAI advertisement for the caseless ACR, which shot both 5.56mm "heavy-bullet" and 4.32mm "sabot-bullet" cartridges.* AAI Corporation

Chapter Twenty one

OFFSHORE PRODUCTION OF M14 AND M16 RIFLES

The M16 Consolidates its Position

Meanwhile, despite all the brave attempts to unseat the M16 with "future" rifles, by the early seventies the M16A1 had settled firmly into the role of the world's most reliable and effective combat tool. As we have seen, the US government had perforce perfected the M16 in a wartime program of developmental attention and retrofit worth many millions of dollars, the end result being that by the end of the Vietnam war, the M16A1 was simply the most tested and most reliable 5.56mm rifle on the market. More than ever, it seemed, the black rifle had considerable "sex appeal". As summed up at an April 1971 ARPA Small Arms Conference by Dr. W. C. Pettijohn, author of numerous studies on the analysis of small arms effectiveness:

> *The M16 has proven itself to be a superior rifle and has been accepted as such on a worldwide basis. It also has potential for mass production in the event of an emergency. There are no weapons currently that can be considered a competitor. Government efforts to develop a successor will proceed slowly. The conference forecasts six to eight million M16 rifles being produced during the next ten year period at a cost of two to three billion [dollars].*

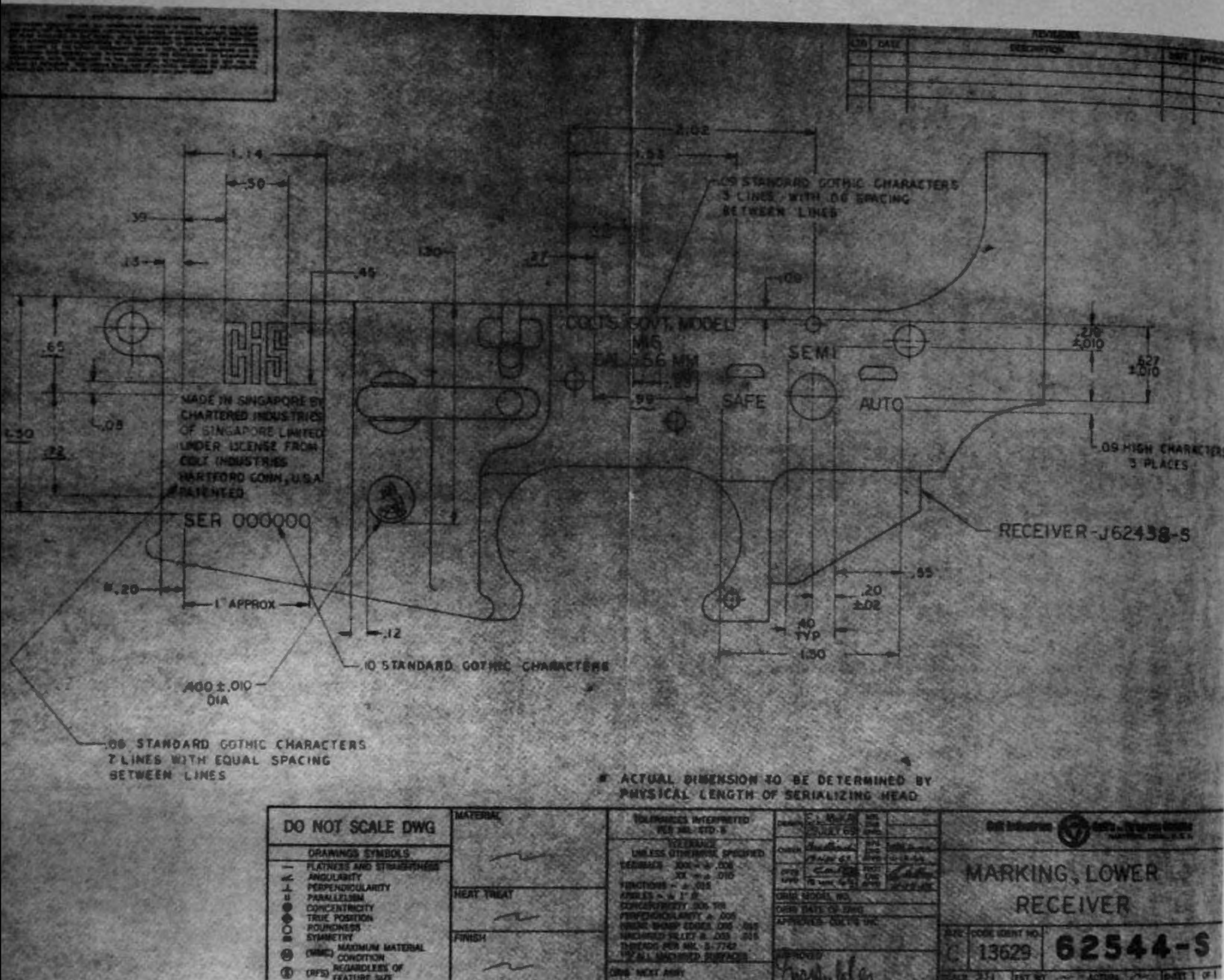
Active, direct American military involvement in the Vietnam war ended in 1973. Later Defense Intelligence Agency estimates were that among much other ordnance, the US-supported Army of the Republic of Vietnam (ARVN) and the Cambodian Army had been forced to abandon roughly 946,000 serviceable AR-15, M16, XM16E1 and M16A1 rifles to the victorious North Vietnamese Army (NVA). In the mid-1980s, when many of these weapons began to appear on the international small arms black market, the M16 became the most widely distributed 5.56mm rifle in the world.

After the Vietnam war was over Colt's had a reliable, battle-proven rifle in the M16A1, and they wanted to sell it abroad. They subsequently found some of their best markets by emulating Belgium's Fabrique Nationale, who for years has offered expensive, but guaranteed, step-by-step licensed-production programs. With a proven "winner" in the M16A1, Colt's found that a number of foreign countries wanted to build their own versions, under license, in their own factories.

Chartered Industries of Singapore

The first such overseas customer was the Republic of Singapore. As discussed in chapter 12, soon after becoming independent from the Federated States of Malaysia, Singapore had been at least partially successful in its controversial bid to contract for the supply of Colt-made model 614s (the export version of the standard USAF M16, which in Colt parlance was known as the model 604), and HBAR "M1s".

In 1967, a fully-integrated group of locally-owned and operated companies was incorporated under the name Chartered Industries of Singapore Private Limited (CIS) to meet the city-state's own defense needs. In 1970, with major technical assistance from Colt personnel residing in Singapore, CIS's Small Arms Weapons Group undertook the manufacture and assembly of the M16 under license from Colt's. Over the ensuing ten years, nearly 200,000 M16-type rifles (without bolt assist; known at Colt's as the model 614-S) were produced. At least 30,000 of these were sold, with US State Department permission, to Thailand.

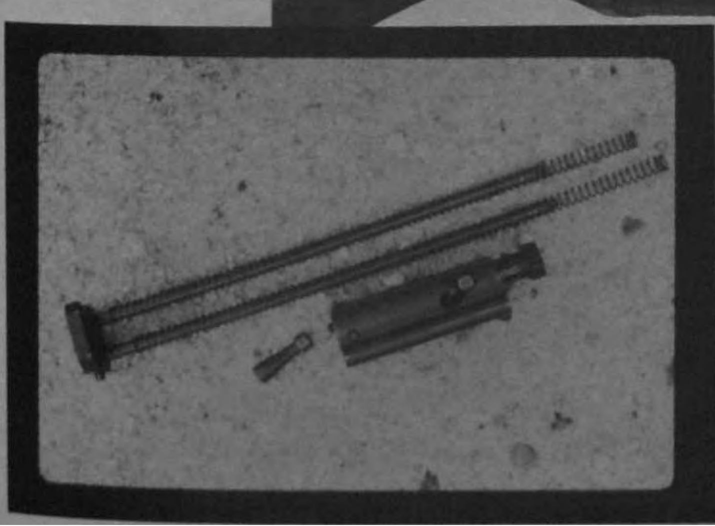


335. Colt factory drawing, dated July 29, 1969 of the markings authorized for the 200,000 M16 rifles (Colt model 614-S) manufactured under license by Chartered Industries of Singapore.

The SAR-80 Rifle and the Ultimax 100 LMG

The expertise thus gained enabled CIS to seek its own fortune. In a gambit to circumvent US State Department control of the M16 technology, the CIS Small Arms Weapons Group subsequently fielded two 5.56mm weapons of its own. These were the SAR-80 rifle, which evolved from the stamped-metal ArmaLite/Sterling AR-18, and the excellent Ultimax 100 light machine gun. Both of these weapons feature conventional gas (impingement) piston operation of the familiar 8-lugged Stoner/Johnson bolt. Many experts agree that the Ultimax 100 is the finest 5.56mm light machine gun in the world today. Interestingly, it was designed for CIS by L. James Sullivan, Gene Stoner's old teammate and the engineer who, as mentioned, had been a major figure in two historic "scaledowns"; the AR-15 for ArmaLite and the Stoner 63 at Cadillac Gage.

336. An early production model of Chartered Industries' 7.5-lb. (3.4 Kg), 5.56mm SAR-80, a copy of the ArmaLite AR-18. The SAR-80 is available with fixed or folding buttstock.



337. Closeup of right side of late model (redesigned pistol grip; ambidextrous magazine catch) SAR-80, showing receiver markings.

Photo courtesy Peter Kokalis

338. Like the AR-18, the SAR-80 receiver hinges up for disassembling. The similarity of bolt and operating rod/spring assemblies is obvious here.

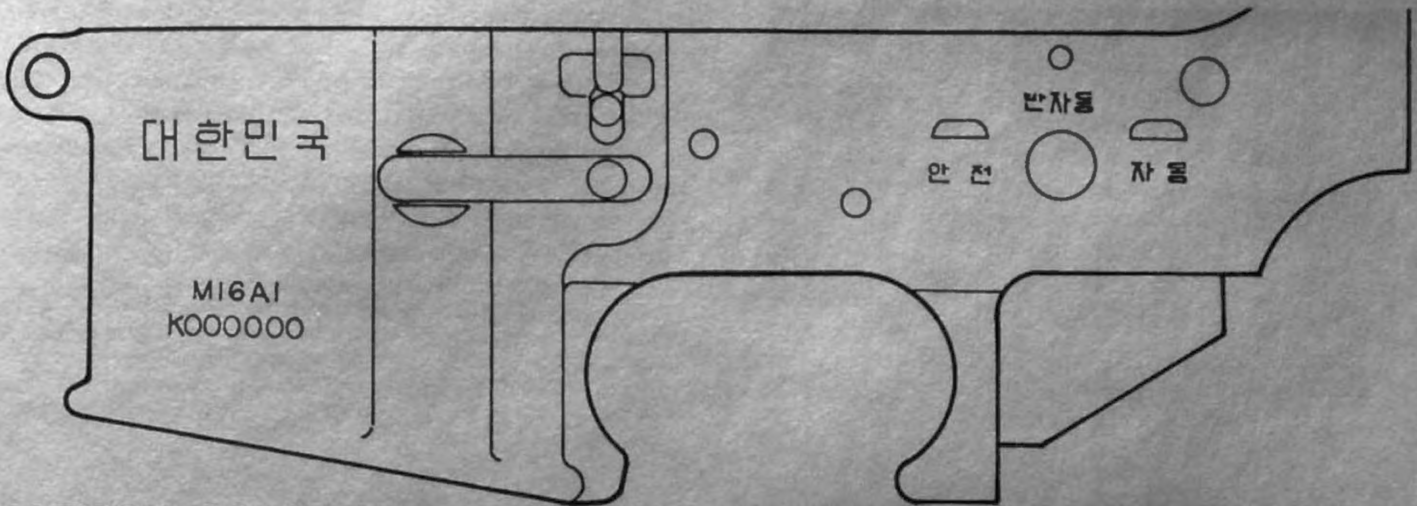
Photo courtesy Peter Kokalis

339. The state-of-the-art in 5.56mm light machine guns: the Ultimax 100, designed (on the revolutionary "constant recoil" principle) for Chartered Industries by L. James Sullivan in 1979. Note the familiar 8-lugged bolt, ready to begin a burst of controllable, open-bolt, full-auto-only fire from the 100-round drum magazine.

The Model 603-K - Springboard for South Korea

Another staunch US ally in Asia, the Republic of South Korea was a target for "most favored" American assistance. The ROK troops who fought in support of the US and ARVN in Vietnam really admired the M16 rifle, and thus there was popular support for Korean adoption of this weapon. Unlike the other licensees, and indeed Colt's itself, all of whom relied heavily on sub-contractors for most of the rifle's components, the plant built with US aid in Pusan was truly self-contained. Every part of the rifle was made in-house, from the receiver forgings and barrels to springs, pins, castings and plastic furniture. Another division of Colt Industries, the Pratt & Whitney Small Tools Division, even equipped a companion factory to make the required cutting tools for the main rifle plant, which was originally known as Pusan Arsenal.

The Koreans favored the Army M16A1 (Colt model 603) with the bolt forward assist feature, so the rifle they manufactured under license from Colt's became known as the model 603-K.



340. Left and right side views of receiver markings used on licensed production of the South Korean M16A1 (Colt model 603-K). Note "K" serial no. range.

The Daewoo "K" Series

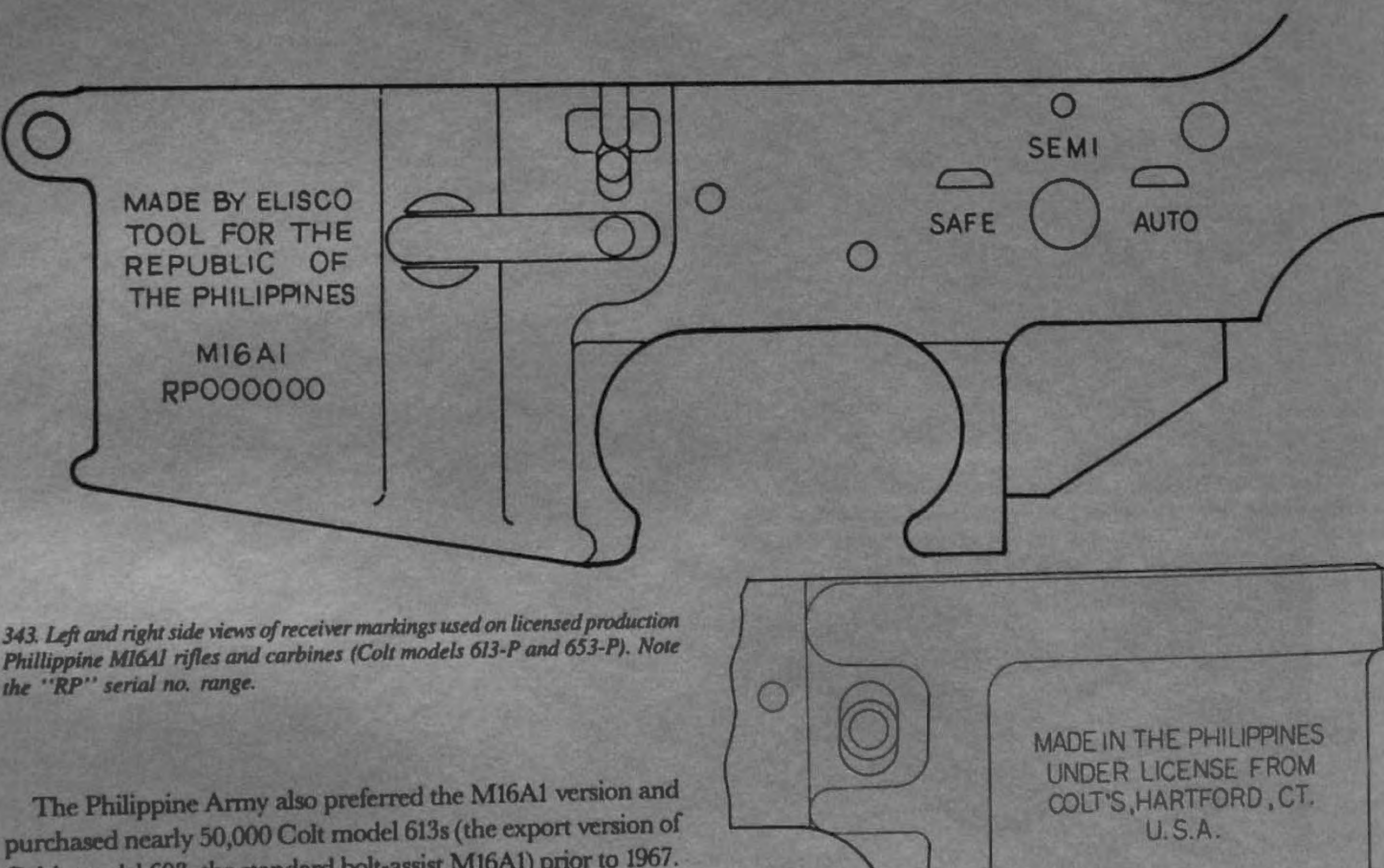
Operational control of the complex facility known as Pusan Arsenal was tranferred to Pusan's Daewoo Precision Industries, Ltd. in January 1983. Subsequently, and for the same reason that had motivated CIS in Singapore, Daewoo introduced its own series of 5.56mm weapons, again highly derivative of the M16 and other successful modern designs. The K1 and later K1A1 carbines use an M16-type gas tube, carrier key and bolt

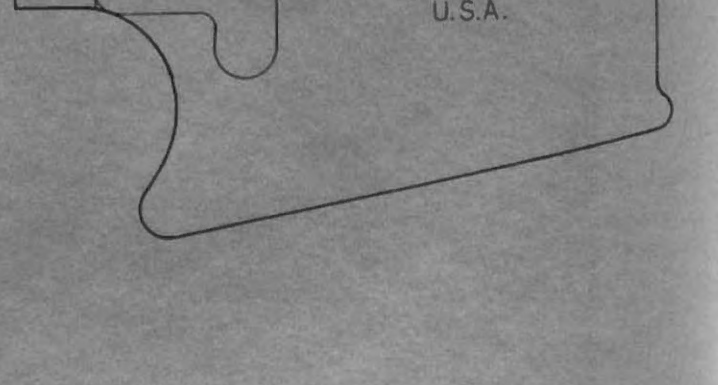
341. The Daewoo "K" series of weapons. From the top: the K2 rifle (with aftermarket silencer) with 8-lugged, M16A1-type bolt functioned by Kalashnikov-style gas piston/operating rod; two 10"-barrel K1s, with suppressors patterned after the XM177E2 SMG (top K1 also fitted with aftermarket silencer); the later K1A1 carbine with rubber-coated, telescoping stock extended.
Photo courtesy Peter Kokalis

(with a receiver-mounted ejector working through a slot in the bolt face), but the bolt carrier itself is a modified AR-18 type: a short, thick (rounded) block reciprocating on an easily-dismounted twin guide rod/recoil spring assembly. The K2 rifle combines the M16-type bolt with a sturdy Kalashnikov-pattern gas piston/operating rod, while the K3 light machine gun is patterned generally after the FN Minimi.

342. Closeup of receiver markings on the Daewoo "K" series. Above: the military K1 with four-position selector, marked in English and Korean. Note the resemblance to the M16 lower receiver, especially in the magazine well area. Below: the civilian-type, semi-auto-only K1A1. Note the takedown button, directly behind the rear sight. *Photo courtesy Peter Kokalis*

The Philippine 613-P Rifle and 653-P Carbine





343. Left and right side views of receiver markings used on licensed production Phillippine M16A1 rifles and carbines (Colt models 613-P and 653-P). Note the "RP" serial no. range.

The Philippine Army also preferred the M16A1 version and purchased nearly 50,000 Colt model 613s (the export version of Colt's model 603, the standard bolt-assist M16A1) prior to 1967. These rifles saw considerable use in the Philippine government's ongoing campaign against Muslim rebels and communist insurgents. In 1967 the Elisco Tool Company of Manila, which incidently today owns the legal remnants of ArmaLite, undertook to manufacture two versions of the M16A1 rifle under license from Colt's. These were the model 613-P standard rifle and a carbine, fitted with the XM177E2's collapsible buttstock and a 14 1/2-inch barrel, called the model 653-P. Many of these weapons have been seen in television coverage of the Aquino revolution.

Taiwan - Gateway to the Orient

Another purchaser of approximately 50,000 Colt model 613s was the government of the Republic of China on Taiwan, presumably with licensed production in mind as had been the case with the other aid recipients. This precedent had been first established early in 1967, when the US and the Chinese Republic on Taiwan had entered into a solemn License Agreement regarding the M14 rifle and M60 machine gun, as follows:

Memorandum of Understanding

between

THE GOVERNMENT OF THE REPUBLIC OF CHINA

and

THE GOVERNMENT OF THE UNITED STATES OF AMERICA

RELATING TO THE LICENCE

FOR THE PRODUCTION OF

M14 RIFLES AND M60 MACHINE GUNS

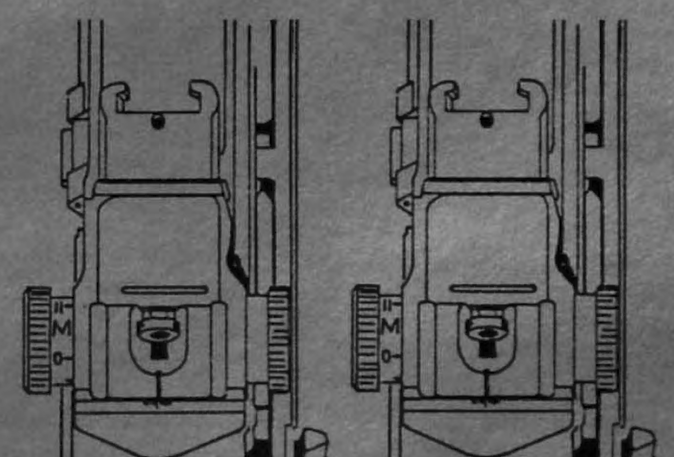
[23 January 1967]

..As requested by the government of the Republic of China, herinafter referred to as the GRC, the GRC will establish facilities in-country within the next two years with the capability to produce the M14 rifle and the M60 machine gun at an annual rate of 6,000 each M14 rifles and 1,200 each M60 machine guns on a single shift (8 hours per day) basis.

It is estimated that the GRC will expend in the United States on a dependable undertaking basis approximately US$4 million for tools, components,materiel, documentation, technical assistance, and assemblies..during the period [FY67] through [FY69].

..The GRC will take all necessary steps to ensure that any classified information furnished by the United States Government, hereinafter referred to as the USG, for the purpose of this program will not be supplied to any third party or otherwise compromised..

For the purpose of the production..of M14 rifles and M60 machine guns under the terms of this Memorandum..and under the authority of the Foreign Assistance Act of 1961..and Section 414 of the Mutual Security Act of 1954..the USG will furnish to the GRC (without cost other than for reproduction and handling) Engineering Drawings, Specifications, Production Data, and other Technical Data..



344. Early and late styles of receiver markings on the US government-licensed production of "Type 57" M14 rifles by the Republic of China on Taiwan. Left: old style markings, reading, top to bottom: "Rifle 7.62 57 shiki *(type)"; "Made in Republic of China (ROC)"; circle trademark of ROC 60th Arsenal; serial no. (000001 to 048655).*
Right: first rifle with new style markings: "Rifle 7.62"; "Type 57 Made in ROC"; 60th Arsenal trademark; serial no. (beginning with 048666).

This authorization does not in any way constitute a license to make, use or sell the..proprietary rights..which may be described in the documentation...The USG agrees to interpose no objection to the duplication by the GRC for the purpose of production of M14 rifles and M60 machine guns, of any special tooling and industrial facilities now used..in the manufacture of such items...If requested, the USG will sell to the GRC, to the extent available, USG-owned surplus production equipment and machine tools [from the defunct H&R M14 production line].

..It is the intent..that items produced..will be interchangeable logistically with items produced by or for the USG..

..Items manufactured..will be identified by appropriate markings and designations to distinguish their source of origin or manufacture..

The Taiwanese were then given not only know-how and machinery to produce the weapons, but also the ammunition:

Office of the Assistant Secretary of Defense

Memorandum for the Director of International Logistics..

PRODUCTION DESIGN DATA TO GRC ON 7.62mm AMMUNITION

30 January 1967

Reference is made to the US-GRC Logistical Support License Arrangement on production of the M14 rifle and M60 machine gun, dated 23 January 1967.

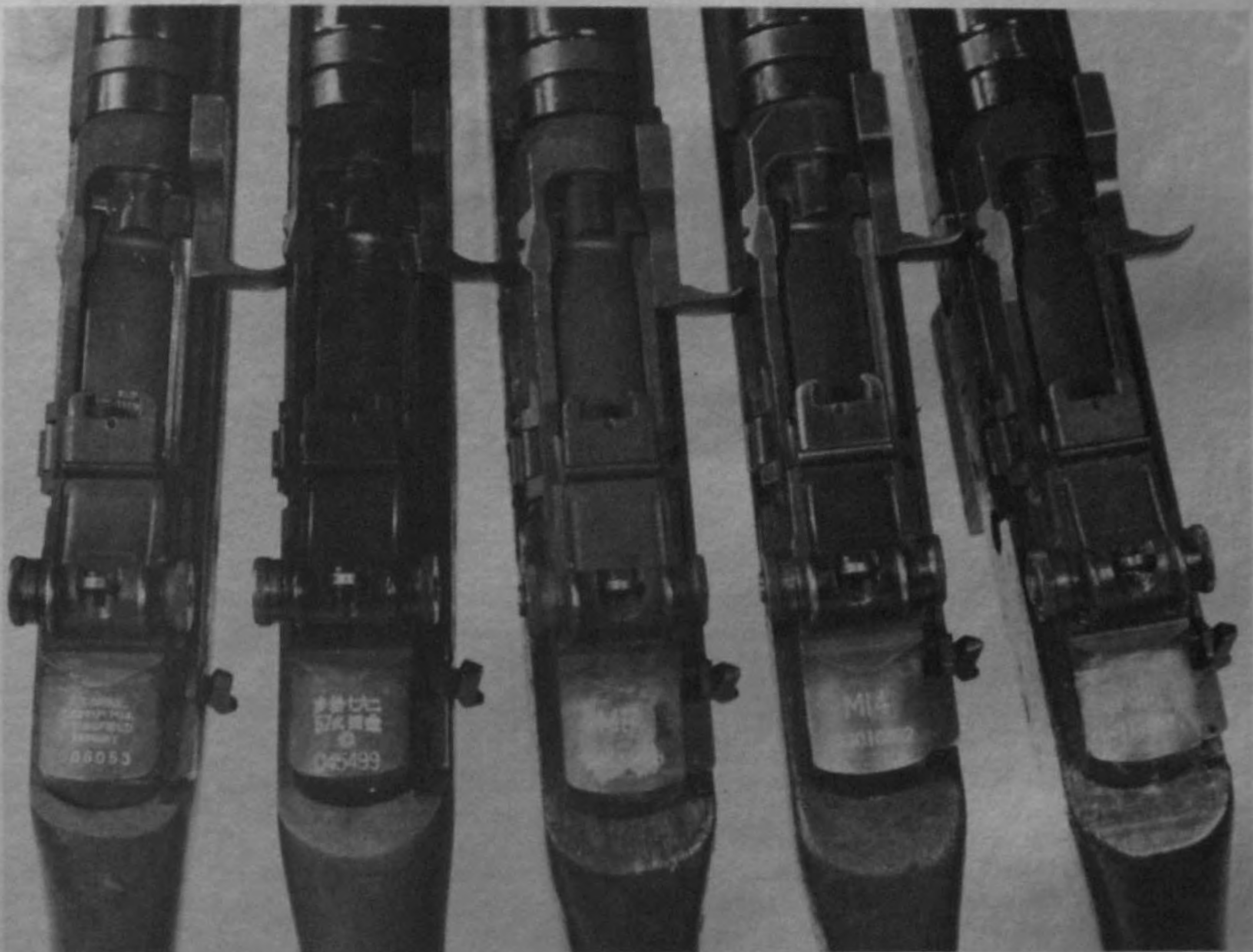
As an adjunct to the above Arrangement, you are authorized to provide production, design data to GRC on the 7.62mm ammunition as requested..subject to industry approval where required. Reimbursement will be limited to reproduction cost of data and any technical assistance requested by GRC.

The 5.56mm T65 Rifle

345. Partially-stripped view of the 5.56mm Taiwanese T65. Note from top: M16 charging handle, new upper handguard; AR-18-type gas piston assembly and M16 bolt assembly sans carrier key; M16-type (bolt closerless) receiver with flip-up rear sight "hump" and no carrying handle; cast-aluminum M16A1-type lower receiver with different contour to lower buttstock.

The Taiwanese also moved on to an ambitious 5.56mm manufacturing program of their own with the most derivative design of any discussed so far - the T65. Manufactured by the Hsing-Ho Arsenal in Kao-hsiung, the T65 is an exact, late-model M16 "lookalike" except for a standard impingement-type gas piston, and no built-in carrying handle. The Republic of China's Marines, Special Forces and Military Police have adopted the T65 to replace their older NATO-caliber Type 57s.

M14 Rifle Production in the People's Republic of China



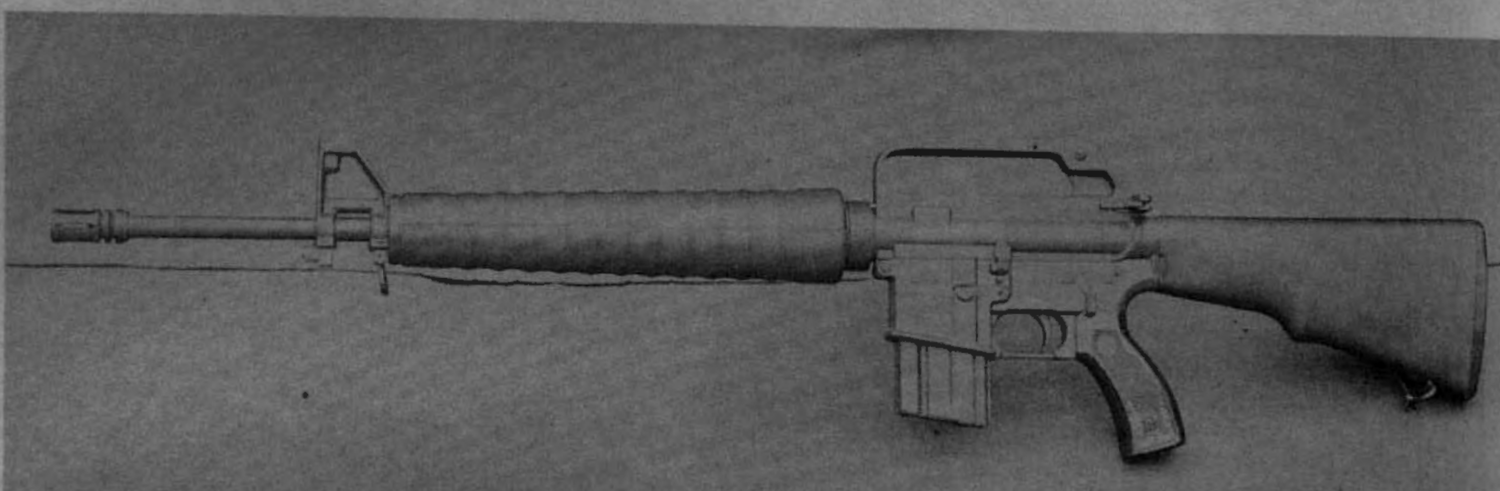
346. Closeup of receiver markings on some typical M14 rifles. From left: 1. genuine US M14, manufactured as part of Springfield Armory's third order for 70,500 rifles, dated March, 1961 (US Rifle M14)*; 2. Republic of China Type 57 rifle (fig. 344); 3, 4 and 5: mainland Chinese "M14s" made by North China Industries (Norinco) of Beijing. Note the 8 (!) digit serials on nos. 3 and 4. Clumsy woodwork, but with metal generally better finished than the ROC Type 57.*

Somehow, by the early 1970s, the megalithic China North Industries Corporation (Norinco) of Beijing (Peking) had also gathered sufficient technical data to turn out what is by all accounts a very creditable copy of the M14 rifle. Norinco is truly a vast and surprisingly enterprising state-owned conglomerate of manufactories, which produces virtually every conceivable item of military field ordnance from pyrotechnics to self-propelled howitzers, including ammunition in every basic caliber of consequence from .22 long rifle to large-bore mortar bombs and cannon rounds. On the hardware side, among many other things Norinco makes sporting and military versions of the TT33 Tokarev (Type 51 and 54) and Makarov (Type 59) pistol, as well as the PPS43 (Type 43) and PPSh41 (Type 50) submachine gun, the AK-47/AKM (Type 56 and later variants) assault rifle; light, medium and heavy machine guns in calibers 7.62x39mm, 7.62x54R and 12.7x108mm; and an automatic cannon in caliber 14.5x114mm. And that's just the *small* arms.

Approximately 100,000 Red Chinese M14s were made up, so the story goes, marked "M14" as illustrated, to arm a communist uprising in the Philippines which never took place. All were apparently fitted for selective fire and chambered for the regular 7.62x51mm NATO cartridge, also made by Norinco using the same distinctive, copper-washed steel that China uses in its East bloc cartridge cases, but bearing, confusingly, British NATO headstamps!

Norinco also produced a semi-auto sporting version of the M14 called the model 305, in two versions: "Type I" with standard stock and flash suppressor, and "Type II" featuring a full-pistol-grip stock and a recoil stabilizer akin to those developed by the US Army Infantry Board and adopted as the short-lived M14A1 (*US Rifle M14*).

The China North Industries' "CQ 5.56mm Automatic Rifle"



347. The China North Industries' "CQ 5.56mm Automatic Rifle", left side view. The selective-fire CQ weighs 7.5 lbs. (3.4 kg) fully loaded, and was designed for M193-type ammunition, with a 1-in-12 rifling twist.

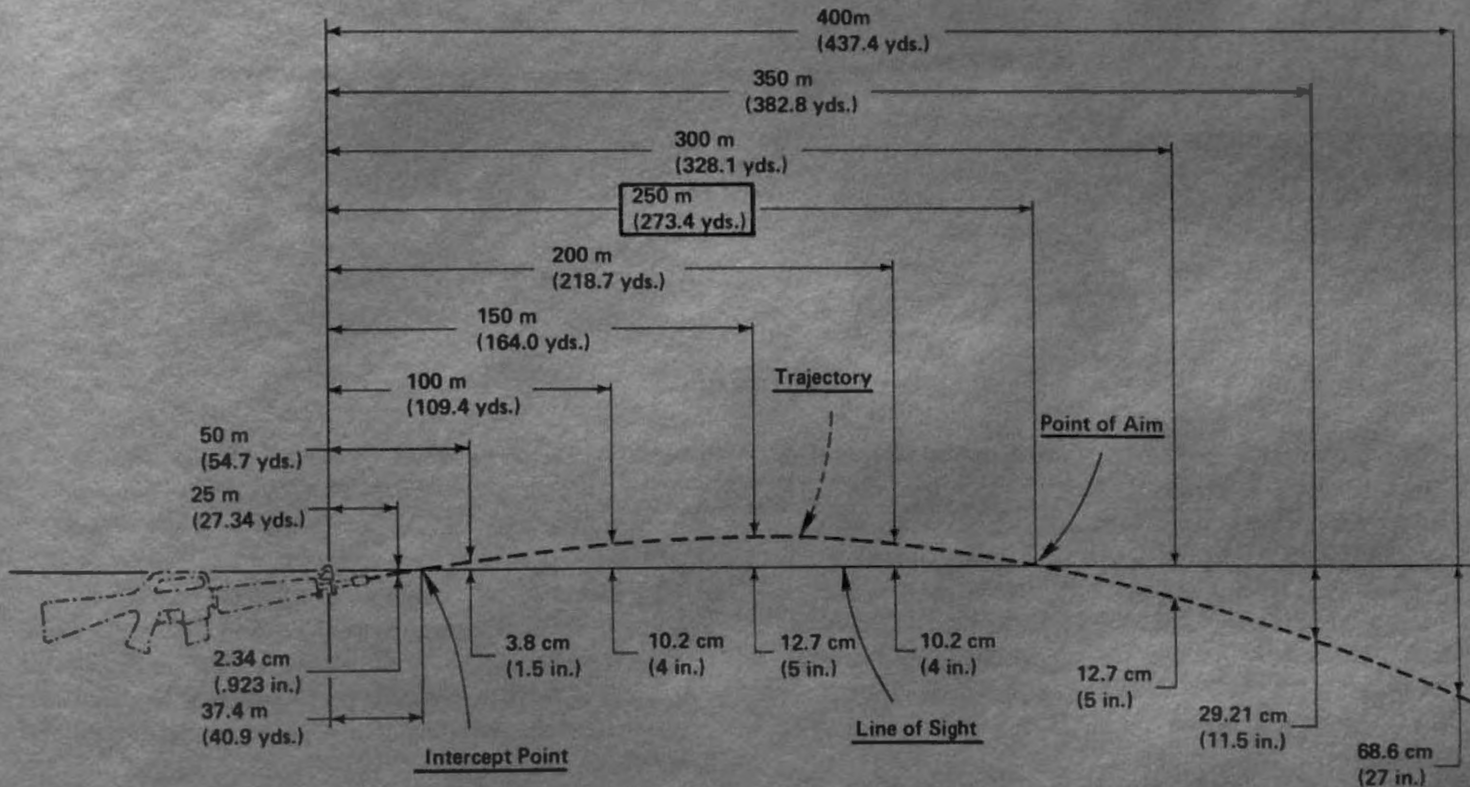
"CQ" is a transliteration of "16" in Chinese: a direct, blatant and unauthorized copy of the M16A1 rifle. The "CQ" rifles are selective fire, with a right hand rifling twist of 1 turn in 12 inches. Apparently thus far Norinco only makes the regular 20-round magazine. The "CQ" has all the features of its US counterpart, including the bolt forward assist. The only immediately apparent differences are a distinctively curved and decorated plastic pistol grip and a round, finger-grooved handguard. All the plastic furniture has a grey, rather than black, appearance.

A semi-auto sporting version of the "CQ" is also offered, called the Norinco model 311.

The Norinco 5.56mm ball round (Type "CJ"; headstamp JS + 2 numerals) features a 55-grain bullet like the M193 with a listed muzzle velocity (V25) of 965 meters per second (3,166 fps).

Chapter Twenty two

ENHANCING THE CAPABILITIES OF THE M16A1 RIFLE/AMMUNITION SYSTEM



Exterior ballistic data based on M193 Ball ammunition fired from the M16A1 rifle and a resultant average muzzle velocity of 966.52 m/sec. (3171 ft./sec.)

NOTE: Max. vertical deviation from line of sight at any point up to 300 m (328.1 yds.) equals 12.7 cm (5 inches)

348. A drawing showing official Army "Recommended Battle Sight Zeroing Range and Projectile Trajectory" for the M16A1 rifle firing M193 ball ammunition, with an average muzzle velocity of 3,171 ft. (966.5 m) per sec. Note that a 250-meter zero results in a shot 5" high at 150m, and 27" low at 400m.

The AMTU Points the Way

Back home in the early seventies, with M16A1 reliability problems just a memory, a number of studies were being made to address the *performance capabilities* of the 5.56mm system.

In a trailblazing test, run at Fort Benning by the USAMTU's T&E Section, three standard and three heavy-barreled M16s, all fitted with Weaver V-4.5 telescope sights, were pitted against

349. Three views of a special, experimental M16A1, designed by the Human Engineering Labs (HEL) for faster target acquisition. Note the highlighted, full-length sighting groove. Used in the SAW trials.

three MTU-accurized M14s fitted with the Leatherwood/Redfield "AR-Tel" adjustable ranging telescope (*US Rifle M14*). All three "M14 (MTU-NM)s" had previously passed the MTU's accuracy standard of a 6.0-inch extreme spread at 300 meters.

A series of bench rest firings at 100 and 300 meters corroborated earlier SAWS study results, indicating clearly that accuracy in the M16, especially past 300 meters, would improve as a result of the introduction of a stiffer barrel, heavier bullet and faster rifling twist:

[US Army Marksmanship Training Unit, Fort Benning, Georgia]

ACCURACY TEST, M16 HEAVY BARREL

12 August 1969

..a representative of Colt's..asked for [USAMTU] assistance in testing the M16 heavy barrel for accuracy..

[one] phase of the test was..firing the [three] heavy barrels ..and..three standard issue M16 rifles..at 300 meters for

Results [in inches] are as follows:

	Ammunition	EV	EH	ES
Heavy barrel wpn. no.				
1	LC 12444	6.8	7.6	8.2
2	"	7.1	7.4	8.6
3	"	5.6	5.1	6.0
average		6.5	6.7	7.6
Light barrel wpn. no.				
4	LC 12444	8.6	10.5	13.1
5	"	7.0	12.4	12.8
6	"	9.9	7.5	10.2
average		8.5	10.1	12.0
[M14 "MTU-NM"] wpn. no.				
7	LC 12045	4.8	3.7	5.3
8	"	3.9	4.4	5.1
9	"	6.4	7.3	8.7
average		5.0	5.1	6.4

Conclusions

The use of sling tension on the heavy M16 barrel does not greatly detract from its accuracy and does not affect point of impact on the target.

The heavy M16 barrel is superior to the light..barrel for accuracy..

..The M14 rifle shows a superiority over the M16 for accuracy and maintains the necessary accuracy for sniping up to 900 meters range. Previous trajectory tests have shown a decided drop of the 55 grain [5.56mm] bullet after passing 300 meters range. If the use of the M16 is contemplated at ranges greater than 300 meters in a sniping role, research should be conducted for a heavier bullet and faster twist barrel combination..

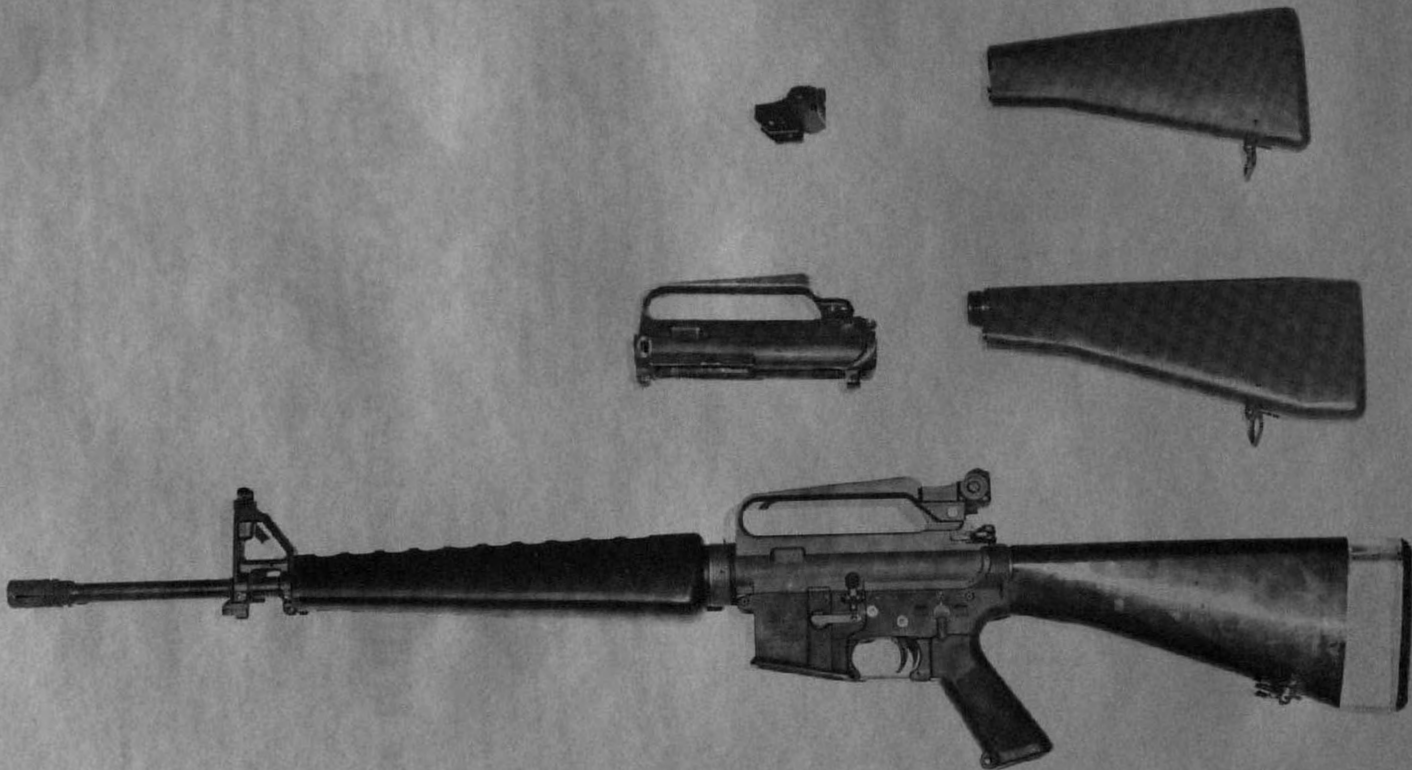
The MTU's National Match M16A1

In February 1972 the USAMTU prepared a lesson outline designed to acquaint all Army MTU personnel with the rationale and ongoing development of a National Match configuration of the M16A1 rifle. While it was admitted that "currently, no known configuration can compete with other National Match rifles over the National Match course", the M16A1 had been the standard US combat rifle for worldwide use since 1968, and as such it had been added to the rulebook for National Trophy matches. In January 1971 the Commanding General of CONARC had ordered all major commands to provide at least one M16A1 rifle team for participation in the US Army championships.

..It is highly possible that the M16A1 rifle will become the only service rifle authorized for use by the All Army Team in the National Matches.

The outline continued:

The M16A1 rifle has been adopted as the Standard Service Rifle. It will be used at all levels of Army competition. As manufactured, the rifle is rugged and reliable when given



350. The Rock Island Arsenal version of the M16A1 National Match Rifle, showing rifle assembled (below) and altered components (above).
Rock Island Arsenal photo dated January 1972, courtesy Lou Woll

standard maintenance. Accuracy, particularly at ranges exceeding 300 yards, is not currently competitive with other National Match rifles. Your Army commanders are going to look to you to provide the modifications necessary to field the most accurate M16s possible for the next All Army championships.

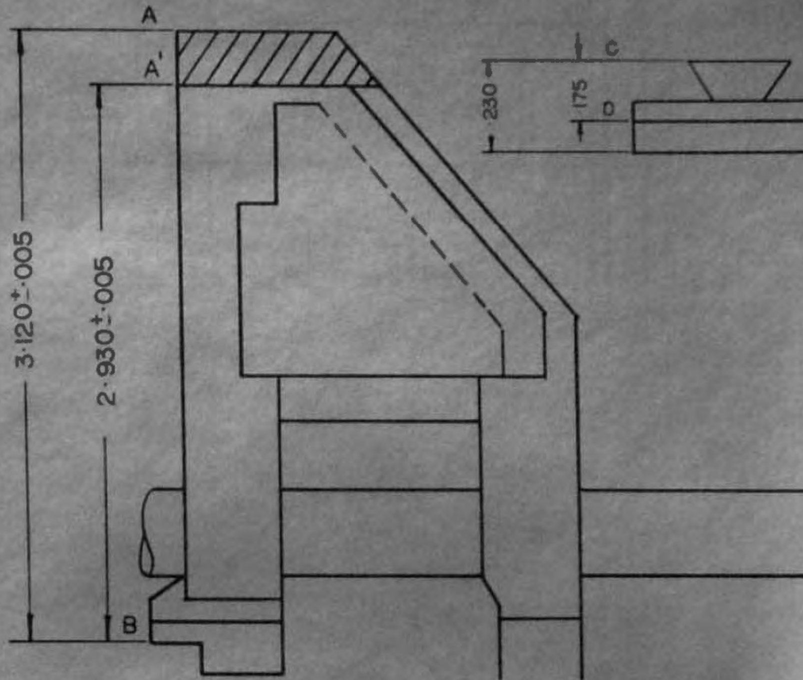
You are familiar with the work done on the National Match rifles in the past [US Rifle M14]. *We must now apply our knowledge and experience to field a National Match M16A1.*

The applicable National Match rules and regulations, as specified in AR 920-30, were next dissected:

..We can use the M16 or M16A1 as issued or modified. We can use the AR-15 as sold commercially. Also we may use combinations of..components to field a National Match rifle. In order to allow civilian use on a relatively unrestricted basis, the AR-15 lower receiver must be used. Specifically, civilians cannot be issued a weapon which was manufactured having full automatic capability, regardless of subsequent modification to remove the full automatic capability.

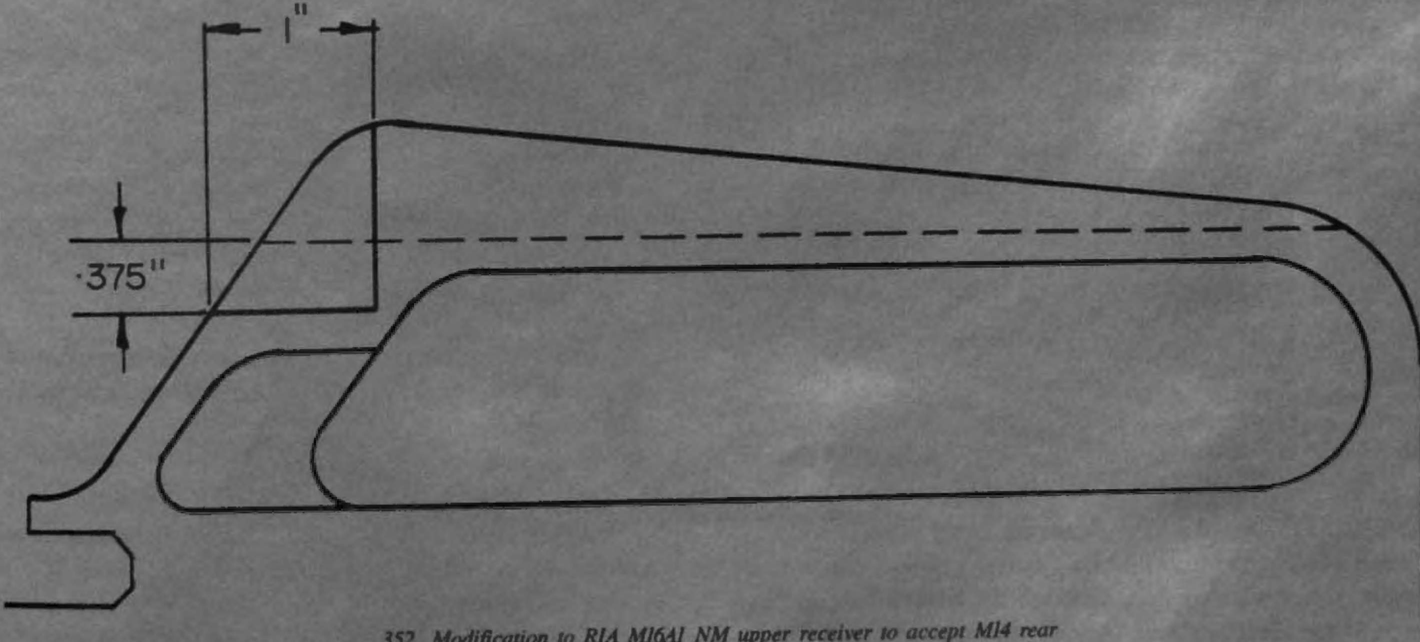
..The most desirable approach is the AR-15 lower receiver ...The next best approach is to use a "stop plate" currently being manufactured by Rock Island Arsenal. The "stop plate" is economical and easy to install..

As the stock is currently manufactured, it is too short for a great many shooters in the prone position. The NBPRP recognizes this fact and lengthening of the stock will be allowed. Approximately 1 1/2" increase..gives a comfortable feel in all positions.

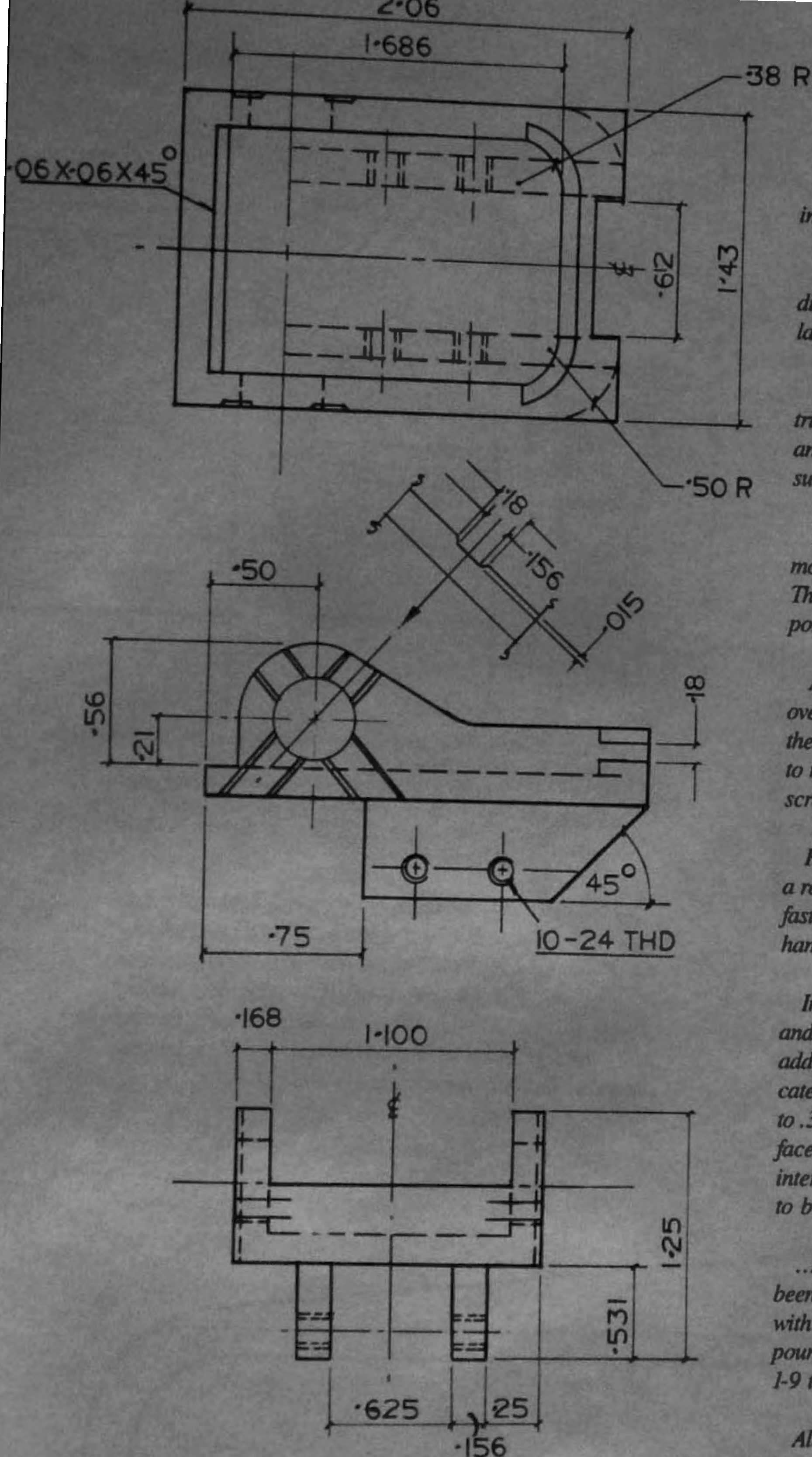


351. RIA modifications to M16A1 NM front sight bracket to accept M14 front sight, showing metal removal from A to A'.
Inset: closeup of M14 front sight pad, sawn from M14 flash suppressor, dimensioned as shown and silver-soldered to center of prepared surface.
Redrawn by Thomas B. Dugelby

..M14 front [and rear sights have] provided the best results to date. A complete description and instructions for installing the M14 sight[s] are provided...We have obtained a maximum sight radius of 21 1/4 inches with M14 rear sight [which] gives 1 inch per click at 100 yards. We have found that the M14 front sight must be reduced in width by 1/3 to provide the most desirable sight picture..



352. Modification to RIA M16A1 NM upper receiver to accept M14 rear sight base. *Redrawn by Thomas B. Dugelby*



353. Manufacturing dimensions for an M14-type rear sight base, screwed to RIA-modified M16A1 NM upper receiver (fig. 350) and fitted with standard components of an M14 rear sight. *Redrawn by Thomas B. Dugelby*

..We have experimented with the internal trigger assembly in several ways to improve functioning. These are:

Added steel bushings to increase the receiver pivot pin diameter to .250 inches in order to reduce vertical and lateral movement between upper and lower receiver.

Hone the release sear's engagement surface to eliminate trigger creep. The hammer notch was filled with silver solder and recut to provide the best possible sear engagement surface.

Removed disconnector and cut away full auto cam on the mode of fire selector switch to eliminate full auto capability. This action provides semi-auto fire only *regardless of.. position of selector.*

Added a trigger stop in front of the trigger to reduce trigger over-travel. This stop is positioned through the bottom of the trigger housing and protrudes up into the trigger housing to reduce downward movement of the trigger bar... A 6/32 screw with lock nut was used.

Removed the trigger return spring and replaced it with a recoil spring placed over the trigger stop which provides faster return of the trigger bar into engagement with the hammer notch.

In order to reduce wear between the aluminum receiver and trigger and hammer pivot pins, external bushings were added to the standard pivot pins. The bushings were fabricated from 1/4-28 hexhead cap screws, heads were reduced to .322" diameter and slotted for a screwdriver. The interior face of the resultant bushing must not protrude past the interior face of the trigger housing...Receiver wall appears to be approx. .090".

..In addition, two heavy barrel versions of the M16 have been tested by the USAMTU. This barrel is standard length, with increased diameter and weighs approximately one pound more than the standard barrel. One version has a 1-9 twist. The other has the standard 1-12 twist.

All the modifications discussed above have resulted in better shooter satisfaction with the feel and handling characteristics of the rifle..

The MTU noted a "significant increase" in accuracy provided by the experimental heavy barrel with the one-in-nine twist, and concluded that, although the M16A1-NM as described and illustrated was "significantly more accurate" than the standard issue rifle, there was much ground to cover (in more ways than one) before the M16 could compete against M21s and National Match M1s in the full course of fire.

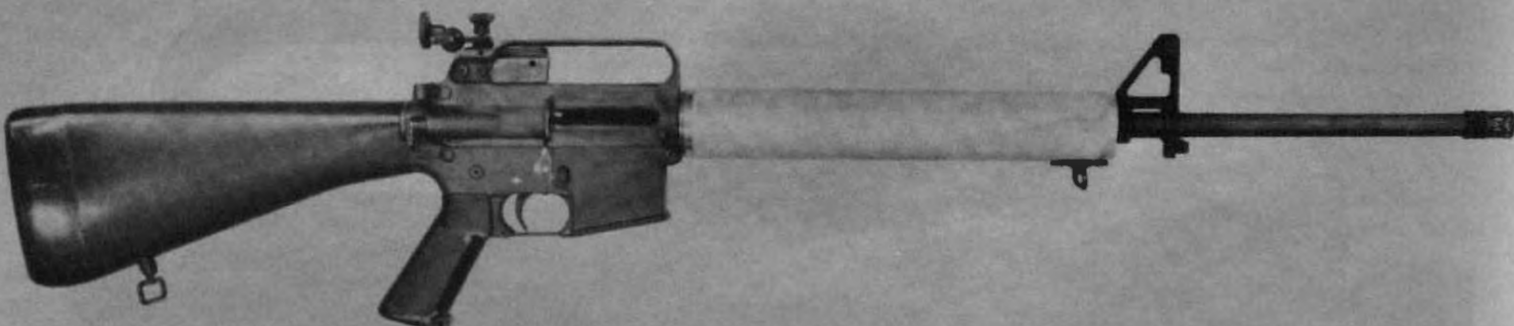
However, tests of the modified rifles, using both issue and handloaded ammunition with bullets weighing from 52 to 70 grains, confirmed that faster-twist rifling and heavier barrels and bullets would further enhance the 5.56mm's accuracy and range capability.

Other Military "Match" M16A1s

354. Left side view of a Match M16A1 rifle built in the US Naval Academy armory shop at Annapolis, Maryland. Note, from front: redesigned, in-the-white flash suppressor on heavy barrel; Redfield Olympic rear sight in special bracket on modified upper receiver; trigger stop adjustment nut (in front of trigger); lengthened buttstock.
NRA photo courtesy Joseph Roberts, Jr.

355. Closeup view of the right side of receiver of the US Navy Match M16A1, showing the "shaved" carrying handle and the method of attaching the Redfield Olympic rear sight. Note the hole, exposing the trigger bar, for easy adjustment of trigger stop. *NRA photo courtesy Joseph Roberts, Jr.*

356. Closeup of forward section of Navy Match M16A1 (above) compared with an early model 01 AR-15. The two holes in the standard M16 sight block were filled with silver solder, the block was slotted front-to-rear, and a new blade sight was inserted, approximating the shape and width of the M14 NM front sight blade (.062"). Note the Match rifle's heavy barrel, necessitating the "opened-up" front sight block. *NRA photo courtesy Joseph Robert, Jr.*



357. Further development of the Navy Match rifle, wherein the upper receiver survived as the basis for this USMC development at Quantico, Virginia. Ten rifles were built with full, non-tapered 24" Hart heavy barrels (1-in-10 twist) free-floated *within a new, one-piece handguard-and-barrel nut assembly, made from seamless metal tubing silver-soldered to a specially constructed barrel nut. Installed with a special spanner, the hollow handguard did not contact the barrel forward of the barrel nut, thus eliminating any downward force on the barrel caused by tight sling pressure. Note the reworked trigger and hammer pivot pins, and the lengthened stock.* *NRA photo courtesy Joseph Roberts, Jr.*

358. A prototype Match rifle built in 1971 by Rodman Laboratories at Rock Island Arsenal. To take further advantage of the free-floating barrel concept (and the M16 gas system's inherently low barrel bending moment) a longer sight radius was provided and the carrying handle was removed, thus making the arm targetscope-adaptable. Note the dummy flash suppressor, used as the pedestal for the Redfield Olympic aperture front sight; the "bobbed" gas block; the scope blocks added to the tubular metal handguard/barrel nut assembly; and the Redfield International rear sight mounted on a special rail affixed to the receiver. *NRA photo courtesy Joseph Roberts Jr.*

Extended-Range 5.56mm Ammunition Developments

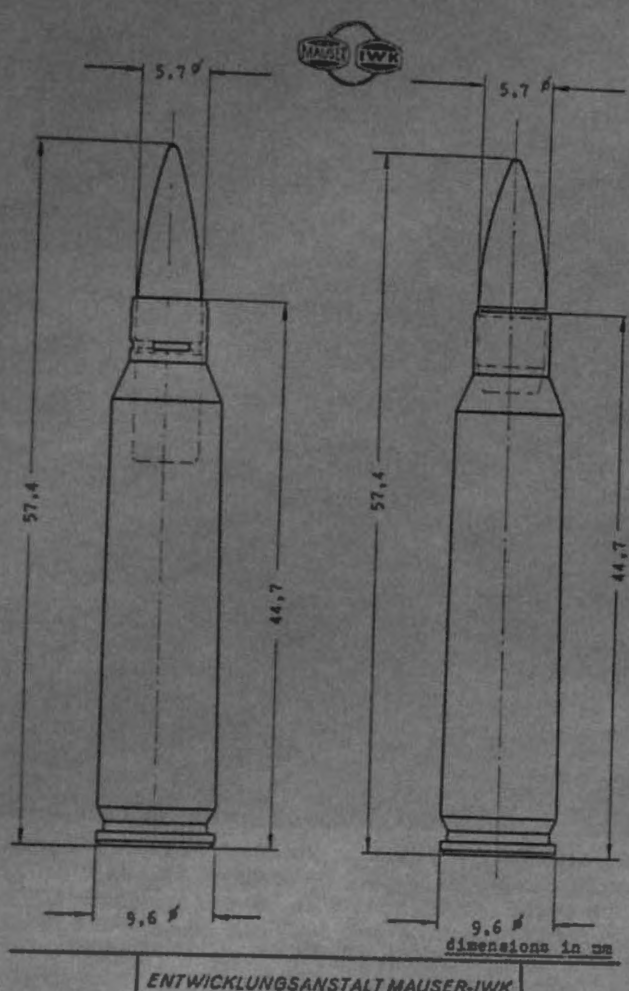
359. A further (actual size) cartridge compendium of improved, extended-range 5.56mm ammunition (compare with figs. 85 and 141). From left: 1. 55-grain M193 ball (nickel-cased dummy of the FN version, the SS92) for comparison, headstamped FN 78; 2. black-tipped, 63-grain tungsten-core AP from NWM (for Stoner machine gun contract circa the SAWS study) headstamped NWM 5,56 67; 3. 77-grain IWK heavy ball, headstamped K 5,56x45 Y IWK; 4. (Black-tipped) Colt special heavy-ball loading, headstamped REM-UMC 223; 5. Colt's 68-grain GX-6235 bullet, headstamped FC 69; 6. green-tipped Olin/ Winchester "Penetrator" 62-grain (4.02-gram) bullet, headstamped WCC 84 (fig. 362); 7. black-tipped, 55-grain US XM777 ball, headstamped LC 77; 8. orange-tipped XM778 tracer, headstamped LC 77; 9. green-tipped 61.7-grain (4-gram) FN SS109, headstamped FN 79; 10. US M855 (SS109 counterpart), headstamped LC . 81 . ; 11. 63.5-grain Canadian C77 ball, headstamped IVI [NATO crossed-circle] 85; 12. copper-washed Canadian C83 proof round (M193 bullet), headstamped same as no. 11.
Editor's collection

Arguably the most valuable result of the American SAWS program (1964-66) had been the credibility which those eighteen months of field trials had ultimately bestowed on the 5.56x45mm cartridge in a longer-range, "light support weapon" role. Aside from the Colt HBARs, just about the only weapon in the world available to establish such credibility at that time had been the Stoner 63 and 63A systems. Indeed, as we have seen, the SAWS trials came about in the first place largely as a result of the Marines' championing the Stoner over the multiplicity of weapons and calibers they were then using, which, they had argued, would only be increased by their adoption of the XM16E1 rifle.

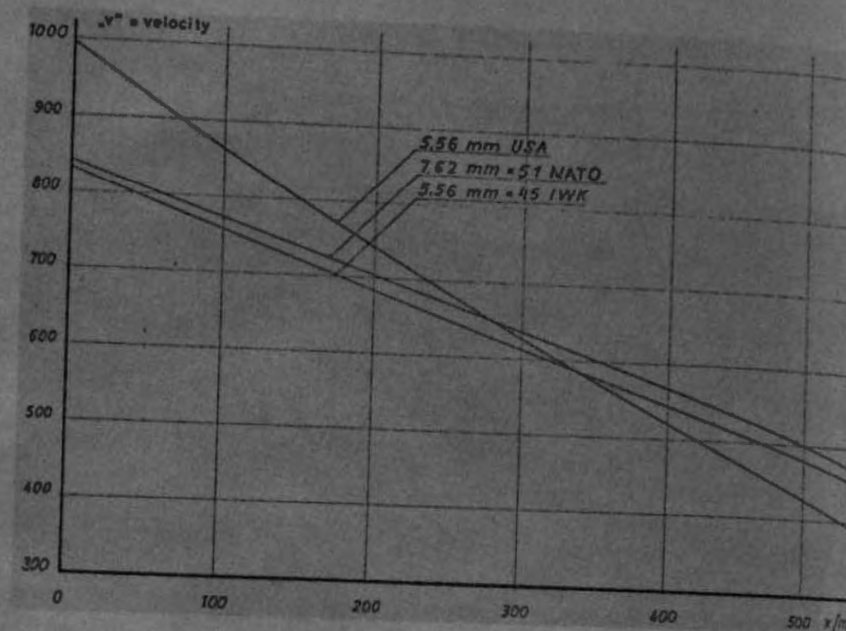
Mauser/IWK (NWM) Heavy Bullets

The first thing the SAWS LMG firings had proved was that the M193 lead-core ball version of the 5.56 round just didn't have enough "punch" to fulfil a real support role beyond normal combat ranges. Ballistic enhancement programs, based on the overall dimensions of the M193 round, were therefore begun both at home and abroad during the period of the SAWS trials.

In support of continuing squad automatic trials with Stoner weapons, Cadillac Gage contracted with the German arms and munitions giant Mauser - Industrie Werke Karlsruhe AG (IWK) and its Dutch-based subsidiary, Nederlandsche Wapenen Munitiefabriek De Kruithoorn N.V. (NWM) for several lots of heavy-bullet ammunition. A series of four bullets was announced in January 1967: a "hard-core" AP with a tungsten carbide core, designed for a regular 1-in-12" rifling twist and supplied in boxes of 40 rounds at a reported cost of $2.90 per round (fig. 359 no. 2); a 700-meter-range tracer; a training blank; and a heavy 5.0-gram (77-grain) steel-jacketed lead-core ball round (fig. 359 no. 3), which required a rifling twist of one turn in 200mm (7.8 inches) to stabilize and produce acceptable accuracy. The 77-grain bullet left the muzzle at 2,722 fps (compared with the 55-grain M193's 3,263 fps in a barrel having one turn in 305mm or 12 inches). However, while the M193 "went subsonic" after about 600 meters' flight, the IWK ammunition was listed as "lethal to 1,000 meters". In a most impressive penetration test through one-inch soft pine boards, IWK claimed the following astounding results:



360. Dimensioned factory drawing of the 1977 Mauser/IWK 77-grain, steel-jacketed lead-core ball round (left) showing comparative length of bullet and depth of seating with M193 (right). *Courtesy Lt. Col. Frank Conway*



361. Under date of January 23, 1967 IWK announced the results of comparative tests of M193, 7.62 NATO and the IWK-developed heavy ball bullets (fig. 360). Included was this chart, entitled "Comparison of velocities for ranges from 0 - 500 m". As Bill Davis had argued earlier, concentrating on muzzle velocity could be misleading! *Courtesy Lt. Col. Frank Conway*

5.56x45mm M193 - 10 boards

7.62x51mm NATO - 16 boards

5.56x45mm IWK - 46 boards

In a move reminiscent of Fairchild's late-fifties scheme to produce the AR-10 at Artillerie-Inrichtingen, Cadillac Gage granted worldwide manufacturing and sales rights to the Stoner 63A1 weapons system to NWM of Holland in 1965. A "production preparation branch" was established at NWM which turned out about 12,000 barrels, but "offshore" interest in the Stoner system did not amount to adoption, and the NWM weapon and IWK heavy-bullet ammunition programs lapsed into obscurity. Most of the 3,000 Stoners ever made came from Cadillac Gage.

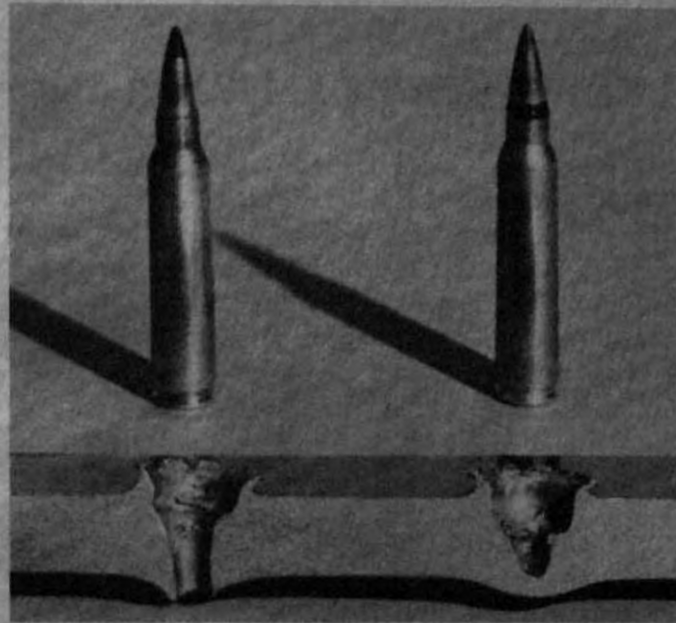
The Davis/Colt 68-grain GX-6235 Bullet

Mr. Davis comments informatively on some relative characteristics of several 5.56mm bullets, beginning with Stoner's adaptation of Frankford's .22 homologue of the caliber .30 M1 ball (fig. 72), and including a description of a 68-grain secant ogive design first made up in 1965 at Colt's (fig. 359 no. 5). Interestingly, this bullet looks remarkably similar to the FN SS109/US M855 (fig. 359 no. 9), later adopted by all of NATO:

..As an aside here, it should be mentioned that [Stoner's] supposedly sophisticated bullet design..had in fact a rather naive error in its application to that particular cartridge. The allowable protrusion of the bullet, which is the difference between the design length of the cartridge case and the design length of the loaded round, was somewhat less than the axial length of the 7-caliber tangent ogive. The crimping cannelure of the bullet was therefore actually located somewhat ahead of the cylindrical bearing surface, encroaching slightly on the ogive. Though the encroachment was small and hardly noticeable except in an analysis of the drawing dimensions, it could readily have been avoided by any experienced ammunition designer, and certainly is not in accordance with the best design practice for small-arms bullets. In the 68-grain boattail bullet designed somewhat later at Colt's for use in their proposed long-range round..this problem

of limited bullet protrusion inherent in the design of the 5.56mm cartridge was avoided by use of a 10-caliber secant ogive of reduced axial length, which allowed crimping of the case mouth into a cannelure located properly on the cylindrical bourrelet, but did not degrade the aerodynamic drag characteristics of the bullet. A similar solution to this problem is found in the Belgian SS109 and US M855 long-range 5.56mm bullets, which in fact bear striking resemblance to the 68-grain long-range bullet proposed by Colt's in 1965.

During the course of development of Colt's long-range round a series of comparative firings were conducted, with the 68-grain Davis/Colt long-range bullet stacked up against the regular M193 ball. In the process, even some 7.62 NATO performance figures were surpassed. Based on firings of his heavier bullet in a 20-inch barrel with a one-in-nine-inch twist, Mr. Davis commented on the results of his experiments in the following report:



362. A picture from an Olin brochure describing the merits of the green-tipped Winchester "Penetrator" bullet (left). Designed like the SS109 (right) with a steel noseplug behind a small airspace (fig. 363), the 62-grain (4.02-gram) Winchester bullet is here shown as giving full penetration of an SAE 1010 hot-rolled 10mm steel plate (from an M16A2 rifle at a range of 240 meters at 0° obliquity), while the "leading competitor's cartridge" gave only partial penetration.

Colt's Inc.

Firearms Division

Ballistic Performance of an Improved Long-Range 5.56mm Bullet (Colt's Design GX-6235)

Remaining Velocities vs. Range [Ft/sec]

Range (yards)	*5.56mm 55-gr. M193*	*5.56mm 68-gr. EXP*	*7.62mm M80 ball*
0	3,270	2,900	2,809
100	2,894	2,660	2,585
300	2,211	2,212	2,167
500	1,627	1,798	1,790
1,000	895	1,076	1,048
1,500	672	869	856

Striking Energies vs. Range [Ft/lbs]

Range (yards)	*5.56mm 55 gr. M193*	*5.56mm 68-gr. EXP*	*7.62mm M80 ball*
0	1,305	1,269	2,625
100	1,022	1,068	2,223
300	596	738	1,562
500	323	488	1,066
1,000	98	175	365
1,500	55	114	244

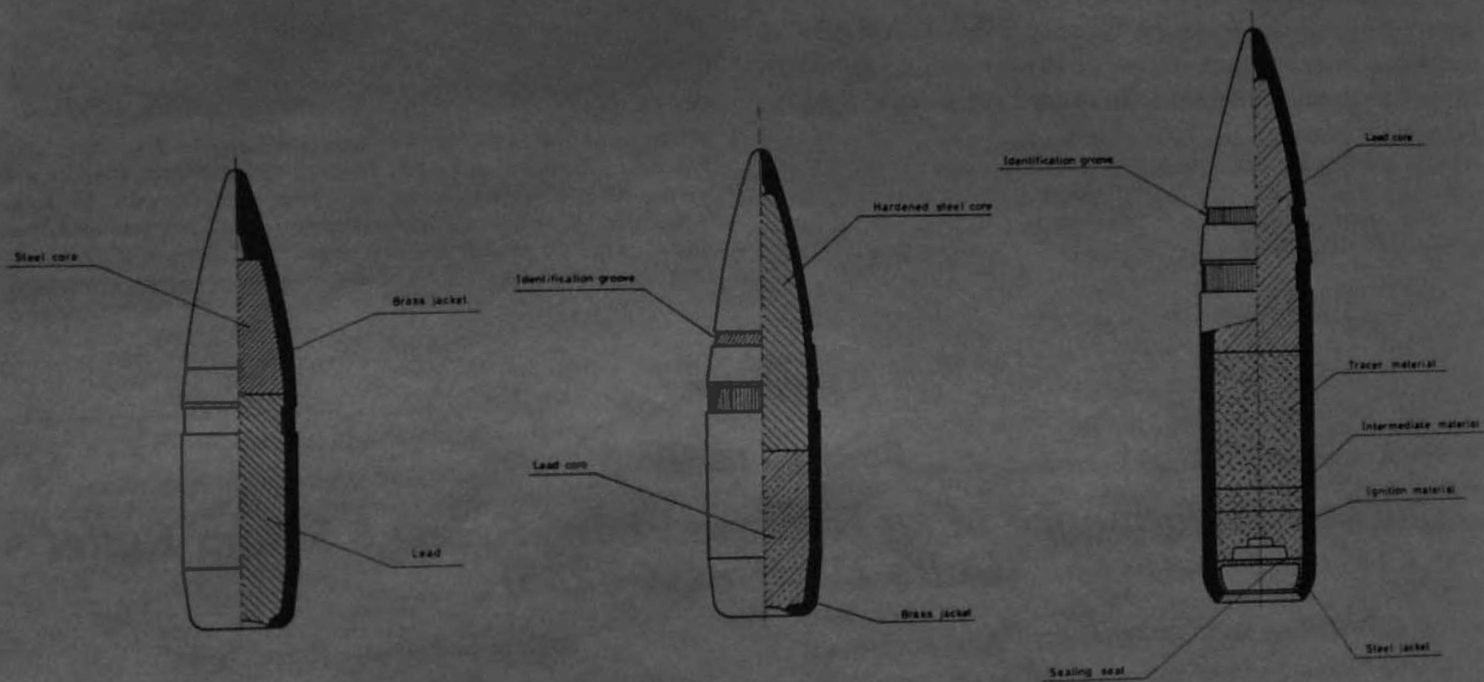
..The striking energy of the 7.62mm M80 is much greater at all ranges than that of any bullet which can be fired from the present 5.56mm cartridge [because] the muzzle-energy level is essentially proportional to the weight of the propellant charge..

While these Colt bullets gave excellent results in 1-in-9-twist barrels, they apparently produced very heavy fouling in 1-in-sevens.

The US Army's XM777: A Short-Lived "Exercise in Interoperability"

There was ample proof that the heavier 5.56mm bullets, while still not equalling the 7.62x51mm in terms of energy, were far superior to the M193 with regard to range and terminal velocity. The only problem was their instability, and hence inaccuracy, when fired through the 1-in-12 rifling twist of the standard M16/M16A1 rifle. As a compromise measure, the US developed the XM777 - a 3.53-gram (55-grain), composite steel-nosed, lead-cored (black tipped) "penetrator" bullet with the exact external dimensions of the M193 (fig. 359 no. 7), and a tracer companion, the orange-tipped XM778 (fig. 359 no. 8). If nothing else, the compromise XM777 proved that the 1-in-12 rifling twist of existing M16s was incompatible with any serious attempt to enhance long-range 5.56mm lethality and penetration. The project was soon abandoned.

The Round of the Future - The Fabrique Nationale (FN) SS109



363. From an FN report dated October 1980 entitled "Improved Ammunition 5,56x45".
Left: the 4-gram (61.7-grain) SS109 ball bullet, which (except at FN) has proven to be a difficult round to manufacture. Note the tiny, unlabelled airspace ahead of the steel core.
Center: the 4-gram P112 AP.
Right: the 4.134-gram (63.8-grain) L110 tracer.
Courtesy Fabrique Nationale Herstal

The M193 version of the 5.56x45mm round was produced and sold by FN as the SS92, with a standard-weight 3.56-gram (55-grain) lead core bullet. By the mid-seventies, however, FN's Ballistic Research and Development Department had perfected its own longer and heavier 4-gram (61.7-grain) "semi-armor piercing" design, featuring a steel nose-piece atop a lead core. Like the earlier Mauser/IWK and Colt designs, the SS109, especially its super-long tracer version the L110 (fig. 363), required a faster rifling twist (FN recommended 1 turn in 7 inches) in order to stabilize.

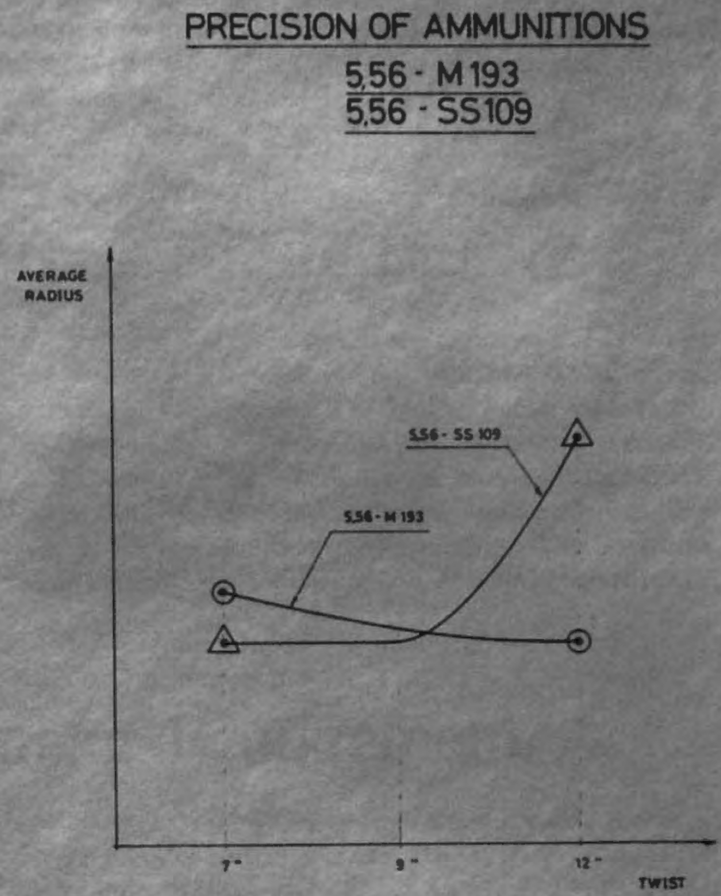
The M16A1 Rifle Remains the US "Arm of Choice"

By 1980, in addition to US and other "future rifle" development, conventional 5.56x45mm rifles and light machine guns were springing up all over the free world. This was not only as a result of the US mutual aid programs in Southeast Asia (chapter 21) and elsewhere, but *independently*. Spain was testing its CETME model L and Lo rifles and the AMELI machine gun (a scaled-down MG3 lookalike); West Germany was looking at Heckler & Koch's HK33 rifle and HK13 machine gun; in Belgium FN had produced the short-lived CAL and later FNC rifles and the clip-or-belt-fed Minimi machine gun; Italy's

"special operations" forces used Beretta's model 70 rifle; France had adopted the bullpup FA-MAS; Israel had adopted the IMI-made Galil; a licensed-production version of the ArmaLite AR-18 was in production at Sterling Armament in England (and had also been produced by Howa Machinery in Japan); and the Austrian Federal Army had adopted the bullpup Steyr AUG.

In spite of all these new 5.56mm weapons, many of which incidentally were built around the Stoner/Johnson 8-lug bolt design, the M16A1 remained the US choice for further improvement. In December 1982 a Fort Benning-based resident systems development contractor discussed the rationale behind a product-improvement program (PIP) for the M16A1 rifle in a memorandum for record:

> *..Since its adoption as the standard service rifle, the M16 has been subjected to considerable criticism concerning its reliability and performance capabilities. Early in the research effort, it became obvious that a serious detriment to an effective rifle marksmanship program was a general lack of confidence in the M16A1 rifle. Therefore, a detailed evaluation of M16A1 performance was conducted to determine adequacy, peculiarities, etc. The findings clearly indicated that the M16A1 was an adequate combat rifle..*



364. A very graphic correlation of the effect of rifling twist on bullet type, entitled "Precision of Ammunitions" compares the SS109 (triangles) with the M193 (circles). *Courtesy Fabrique Nationale Herstal*

Weapons for the Eighties - the NATO Small Arms Trials of 1978-1979

It will be remembered that the *first* acrimonious international standardization talks, begun in 1946 among the nations of the victorious "Atlantic Alliance", had succeeded only in a rather forced agreement on the US 7.62x51mm *cartridge*; try as they might, no common *rifle* could be found that all could, or would, agree on.

By the late sixties these agreements had expired, and two disturbingly divergent trends had become obvious within the NATO community. First, regardless of its superior striking energy, the 7.62x51mm round had been abandoned in "individual weapon" development. Second, despite the veritable spate of new rifles and squad automatics chambered for it, the 5.56x45mm cartridge, at least the US M193 version, was decidedly not everybody's "cup of tea". As mentioned in chapter 20, at least two NATO nations were by the late seventies pursuing unique and individual design programs aimed at superseding, not to say obsoleting, the American 5.56mm round: Germany with its joint Heckler & Koch -Dynamit Nobel 4.7x21mm OH (*ohne hulse*, or caseless) *Gewehr II*, and Britain with the 4.85x49mm Enfield bullpup XL64 series (recently adopted as the 5.56x45mm L85A1).

In this Tower of Babel atmosphere, the ironically-acronymed NATO Small Arms Test and Control Commission (TCC) could see the danger of losing the commonality so painfully gained in the earlier 7.62 NATO round. Even though the 7.62's time had obviously come as a viable rifle or "individual weapon" (IW) cartridge worthy of further development, virtually all NATO medium machine guns were chambered for it.

The answer was found in a new series of NATO small arms trials, aimed at establishing a *second* smaller and lighter standard infantry caliber *before* the various member countries each stepped out with its own non-standard cartridge. A secondary goal, that of establishing a new standard NATO rifle, was also hopefully included even though the odds of its attainment appeared even steeper than they had been in 1946. Nevertheless there were strong economic, industrial and political considerations attendant upon the trials, and competition among the eleven participating nations was keen.

The salient weapons and cartridges featured in the 1977-1980 NATO trials were as follows:

Country	Ammunition	Rifle (IW)	LMG (LSW)	Remarks
Belgium	7.62 NATO (SS77)		MAG-58	control LMG (7.62mm)
	5.56 SS92			
	5.56 SS109	FNC		
	5.56 SS109		MINIMI	
France	5.56 (M193)	FA-MAS		
Germany	7.62 NATO	G3		control rifle (7.62)
	7.62 NATO		MG3e	
	caseless 4.7x21mm	G11		
Netherlands	5.56 (M193)	MN1		(Israeli Galil)
United Kingdom	4.85x49mm	XL64E5		right hand ejection
	4.85x49mm	XL68E2		left hand ejection
	4.85x49mm		XL65E4	right hand ejection
	4.85x49mm		XL69E1	left hand ejection
United States	5.56 M193	M16A1		control rifle (5.56)
	5.56 XM777/	XM778		
	5.56 XM855	(SS109 equivalent)		

Engineering tests were performed at Bourges in France (machine guns) and Meppen in Germany (rifles). Ammunition testing was done at the UK's Cold Meece facility, formerly Swynnerton, in northern England, while Canada hosted the Arctic portion of the military trials at CFB Shilo in Manitoba. The rest of the military trials were conducted at the West German Hammelburg Infantry School.

As for the ammunition, it was soon clear that the M193 could be, indeed had been, superseded. Again as part of the legacy of the American SAWS/SAW trials, the two characteristics which observers took stock of most were long-range accuracy and penetration. The various types of "improved" 5.56x45mm cartridges (and others of even smaller bore) were unprecedentedly effective at ranges far beyond the once-heretical 300 or even 500 meters:

Ammunition type	Bullet weight		Rifling twist (1 turn in)		Penetration (meters)	
	grams	grains	inches	mm	NATO plate	US helmet
SS77 (FN 7.62mm)	9.33	144	12	305	620	800
M193 (US 5.56mm)	3.56	55	12	305	400	515
SS109 (FN 5.56mm)	4.00	61.7	7	178	640	1,300
XM777 (US 5.56mm)	3.53	54.5	12	305	410	820

..As a result of this..technical and military programme, 5.56mm has been adopted as second standard NATO calibre for small arms and the Belgian SS109 ammunition has been selected as a basis for standardization of ammunition for the second NATO calibre for small arms.

Thus the improved characteristics of the heavier bullet used in the SS109 and its American counterpart the XM855 allowed full pursuit of NATO's stated goal for the "post-1980 family" of small arms - a *two-caliber* system based on each member nation's preferred 5.56x45mm individual weapon (IW) and *light support weapon (LSW)*, backed up by medium support weapons (MSWs) in caliber 7.62x51mm.

The Marines Examine Four Future Options

In September 1979, with Vietnam already a six-year-old memory, a strategy meeting was held at USMC headquarters. The purpose was to examine ways to improve the status and effectiveness of the Marines' three-caliber inventory, which then consisted of 5.56mm M16A1s, 7.62 NATO M60s and .30M2 Browning machine guns (still in use on some Marine tanks). After some discussion, it was decided to limit the investigation to four possible avenues of approach. The first proposed the reintroduction of the M14 rifle, while the second advocated the retention of the M16A1 as it then was. Neither idea was met with any great enthusiasm. The third suggestion was to review as many other currently available military weapons as possible in the hope of finding a clearly superior successor to the M16A1. After a quick whip-round of the free world's offerings, this search was abandoned as "disappointing". The focus then concentrated on the fourth option, improving the M16A1.

The USMC Statement of Requirement

In the absence of any similar enthusiasm from the Army, whose inventory of M16A1s was still quite substantial, the Marines began unilateral negotiations with Colt's in January 1980, contracting for the supply of three rifles modified in accordance with the USMC's primary requirements. Encouraged by NATO's acknowledgement of the enhanced range capability of the FN SS109/XM855 bullet design, the Marines later formalized their requirements as follows:

- a sight adjustable to 800 meters.

- a bullet with better accuracy at 800 meters and the capability to penetrate all known helmets and body armor at ranges of 800 meters.

- a rifle with more durable plastic parts and barrel which will take a beating during bayonet training and extended field exercises.

- the replacement of the full automatic capability with a burst mode which fires a maximum of three rounds with each pull of the trigger.

US Navy M16A1 Heavy-Barrel Heat Dissipation Trials

Having received two special test rifles from Colt's in the summer of 1980, the Naval Surface Weapons Center (NSWC) at Dahlgren, Virginia conducted a series of tests to assess the heat dissipation and dispersion characteristics of Colt's heavy barrels and two types of new handguards and heat shields. Excerpts from the NSWC's final report are as follows:

Improved M16A1 Rifle Instrumented Tests and Results

20 August 1980

Background and Introduction

The M16A1 assault rifle..is currently the standard service weapon in use by the US military...During its years of service life, several aspects of the weapon's design and performance characteristics have come under criticism from users...The shape and individual natures of the left and right handguards detract from the performance of the rifle during sustained fire and cause logistical problems when the handguards must be replaced. In addition, the physical strength of the barrel and buttstock..sometimes prove inadequate..in the field, and bent barrels and cracked buttstocks result.

365. From the August, 1980 1-in-12 heavy-barrel trials conducted at the Naval Surface Weapons Center, Dahlgren, Virginia. Top two rifles (serial nos. 4833958 and 4833992) are fitted with heavy barrels (note the difference in handguard ventilation holes); bottom two (serial nos. 4833967 and 788939) are standard M16A1s.

Photo courtesy Fred Willis

In an attempt to alleviate some of these difficulties.. Colt Firearms has proposed several changes in..configuration... These modifications include..interchangeable handguards (upper and lower)..purportedly having improved heat shielding characteristics and increased mechanical strength, and ..a strengthened barrel with thicker walls. Two experimental weapons having these characteristics were assembled by Colt Industries and presented to the Marine Corps for their perusal and comment..

..All parts in the actions of all four test weapons..were standard M16A1 configuration...Twist of rifling: all 4 weapons - 1 turn in 12 inches.

Results and Discussion

..experimental guns..each weigh approximately 1.3 pounds more than a standard weapon. Because this weight has been added to the barrel, the center of gravity..is slightly forward...This forward shift..positions the c. g. more nearly equally distant from the right and left hands when the weapon is held in firing position, and is responsible for the somewhat improved handling qualities of the experimental guns..

Long range dispersion [test]:

..consisted of firing each weapon at a target located 200 yards downrange...Each weapon was mounted in a machine rest [figure 366] during firing. Two groups of 20 rounds each were fired from each weapon...Each group was measured [by finding]..x = length in inches of one horizontal side of a rectangle enclosing 90% of the pattern [and] y = length..of one vertical side..

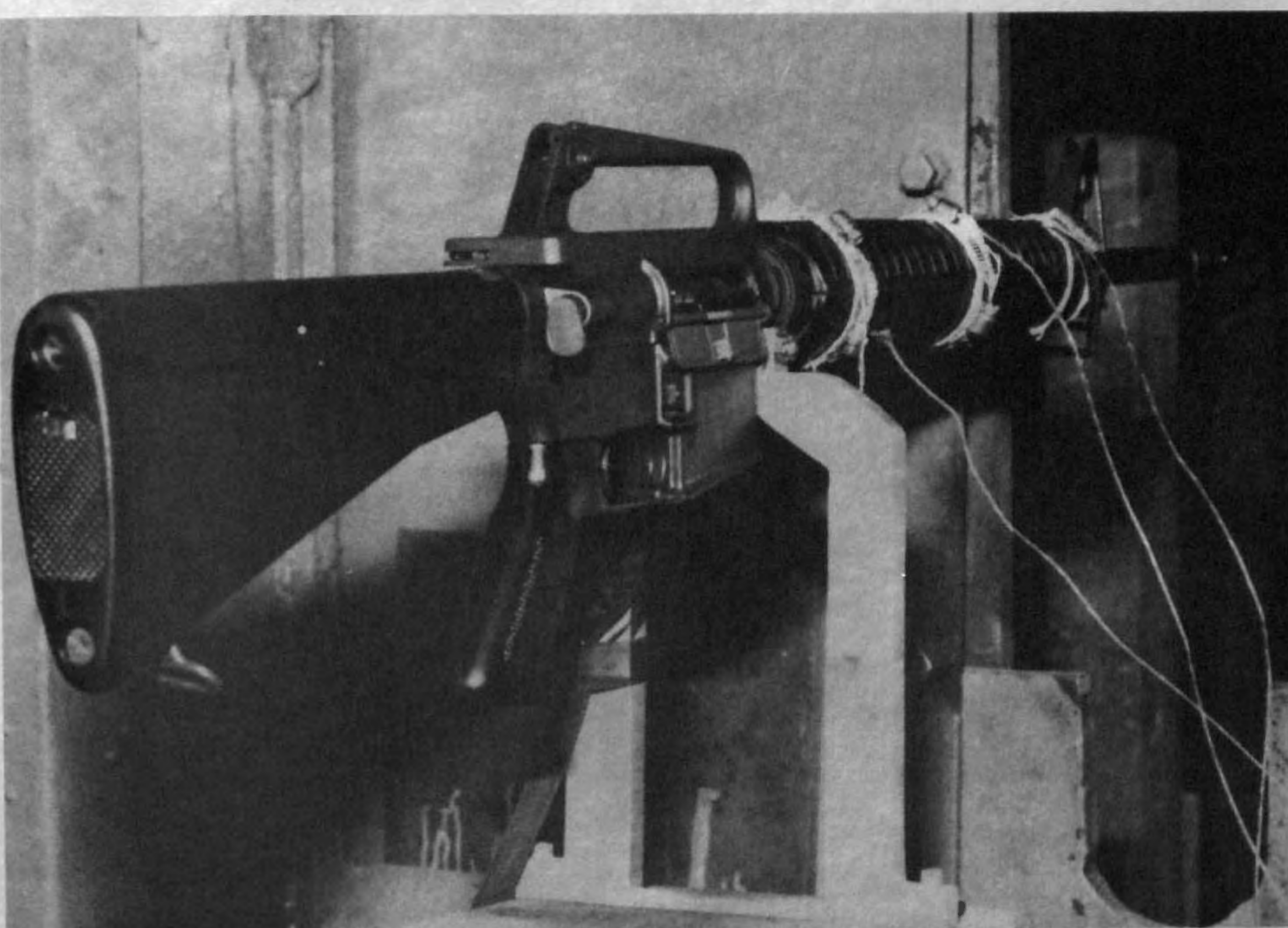
	X	Y
Automatic fire		
strengthened barrel, av.	*9.40*	*14.15*
standard barrel, av.	*16.50*	*15.10*
Semiautomatic fire		
strengthened barrel, av.	*4.0*	*4.25*
standard barrel, av.	*7.20*	*7.25*

Barrel surface temperature measurements:

Thermocouples were mounted on the..handguards as shown...Each weapon was fired in 25-round bursts with 1 minute cooling between bursts to a total of 300 rounds.

	Maximum handguard Temperature (°F)
strengthened barrel [and] round (test) handguard	*112*
standard barrel [and] handguard	*194*
strengthened barrel with standard handguard	*164*
standard barrel with round (test) handguard	*121*

Total [stoppages] - 3..in 5,743 rounds = 1,914 rds/stoppage.



366. One of the heavy-barrel M16A1s "wired" for heat-dissipation trials, during the US Navy trial of August, 1980. *Photo courtesy Fred Willis*

Conclusions:

Experimental weapons..shot smaller patterns at both [70- and 200-yard] test ranges...the difference in dispersion was due largely to the stiffer barrels..

Barrel surfaces..remained cooler..due to the extra steel in the experimental gun barrel tubes. Data also indicate a difference between..location of the hottest area of the

barrel during firing. This information should be used in finalizing barrel design to locate, if possible, the hottest barrel region in an area not covered by the handguards.

The experimental handguards and heat shields ..represent significant improvement..in dissipating heat and protecting the shooter's hand. The..full hole patterns in each half are preferable to the other experimental configuration [figure 365] from a logistics point of view; the tests also indicated that they are equally effective in heat absorption..

It was generally agreed by all shooters participating..that experimental weapons..were overall somewhat easier to handle and point..and that there were no significant differences in ease of control during fully automatic fire..

The NSWC recommended that the experimental rifles be field evaluated, and that if any future tests proposed the lightening of the new barrels by 1/2 pound or more, these should be ''fully weighed against accompanying losses in heat absorption characteristics and decreases in barrel stiffness and strength''.

Chapter Twenty three

THE THIRD-GENERATION M16

Colt's Improved Open-Bolt HBAR

367. The latest model of Colt's HBAR M16, which fires from an open bolt. Note, from the front: M60 bipod; lightened gas/front sight block somewhat reminiscent of the short-lived Colt M703 (fig. 274); new square-section handguard for greater heat dissipation, with front pistol grip and carrying handle; click-adjustable (windage and elevation) rear sight, mounted in modified upper receiver; lengthened buttstock.

JSSAP's Product Improvement Program ("PIP") Rifle - the "M16A1E1"

Tests with the Marines' four rifles aroused the interest of the management committee of the Joint Services Small Arms Program (JSSAP), who at the time were persevering through a long and acrimonious series of trials designed to select a new service pistol. JSSAP approved a joint-service rifle program and ordered 50 Product Improvement Program (PIP) M16A1s from Colt's for delivery in November 1981.

JSSAP tasked the USMC Firepower Division at Quantico, Virginia to oversee the Marine portion of the trial of the new rifles. Accordingly, the Marines conducted a modified operational test (MOT) from 23 November to 11 December 1981 using 30 of the PIP rifles and 30 standard-issue M16A1s, and employing 20 Marines and 10 soldiers from the 197th Infantry Brigade at Fort Benning. For identification purposes, the PIP rifles were designated the "M16A1E1".

The result of these Marine tests was a most favorable assessment of the PIP rifle. The final report listed a number of the M16A1E1's advantages as follows:

368. Above: standard M16A1.
Below: One of the first 50 Product Improved (PIP) rifles, called the "M16A1E1", ordered in 1981 by the Marines for trials with the USMC Firepower Division at Quantico, Virginia.
The Marines had been agitating for years for a common-caliber weapon system: as we have seen, their persistence had provided the impetus, not to say the necessity, for the SAWS (Small Arms Weapons Systems) and later SAW (Squad Automatic Weapon) trials, wherein was developed the USMC-sponsored, removable-barrel XM106 (fig. 319). Thanks to intensive, parallel research done in the improved HBAR program (fig. 367), Colt's was ready when the Marines came calling for product improved (PIP) rifles. The first M16A1E1 rifles were delivered just 14 days from placement of order.
NRA photo courtesy Joseph Roberts, Jr.

[USMC Firepower Division, Quantico, Virginia]

M16A1E1 TEST RESULTS AND FINAL REPORT

21 May 1982

[Advantages:]

- Ease of training (handling and sight movement). [The Marines are trained to engage targets beyond combat ranges by adjusting their sights, rather than by "holding over"].

- Increased effectiveness at long ranges (more hits, better accuracy, and greater penetration). [The Marines are virtually the only fighting force in the world who still train individual riflemen to engage targets past 300 meters].

- Improved handling characteristics and durability in hand-to-hand close combat.

- Reduced barrel jump and muzzle climb during automatic and rapid fire.

- Improved sighting characteristics providing quick target acquisition for moving targets and better detection of targets in low light conditions at close ranges..

- Increased ammunition conservation and more effective use of ammunition with [3-round] burst control device..

- Can use NATO type improved ammunition (XM855) which provides increased performance and penetration at long ranges.

369. *Right side view of early M16A1E1 rifle. Not yet fitted with the spent case deflector "lump" on the receiver (fig. 371).*

370. *Closeup of receiver markings of the early M16A1E1, made up on "M-16A1" lower receiver serial no. 4704772. Standard M16A1 pistol grip. Note modified markings on the (3-position) selector: AUTO is replaced with BURST.*

Adopting the M16A1E1

The product-improved (PIP) "M16A1E1" was officially type classified the M16A2 in September 1982, and adopted as Standard 'A' in November 1983. As noted, the singular impetus provided to the PIP program was from the Marines, who due to "declining inventories" of M16A1s had already ordered 76,000 of the new rifles. In acknowledgement of the Marine contribution, Colt's presented M16A2 serial no. "0001 USMC" to Marine Maj. Gen. William G. Carson on March 14, 1984. The specially-marked rifle was intended to symbolize the first M16A2 off the line, although by that time the Marine Corps' MTU at Quantico had already accepted the first 1,500 rifles for use in Divisional Matches.

As noted, the Army, although the senior service, had a much less critical inventory problem, and consequently had less interest in the PIP program's recommendations: the Army did not contract for any appreciable number of M16A2s until 1986. In the face of this less-than enthusiastic Army attitude, at the same ceremony Colt's presented M16A2 serial no. "0001 USA" to the Army's representative of the Chief of Staff.

371. Right side view of early production M16A2 rifle. What appears to be a massively heavier barrel is controversially heavy in its front section only (fig. 374). Note the prototype spent case deflector, attached to receiver.

Twelve Distinctive Features of the M16A2

Although the 7-pound M16A1 and the 7.9-pound M16A2 rifles look much the same at first glance, enough changes have been made to render the M16A2, in the words of one report on the subject, "for all intents and purposes, a different weapon".

Starting from the front end, the major changes in the M16A2 over its predecessor are as follows:

1. The flash suppressor is now also a muzzle brake. This fourth iteration of a muzzle device for the M16 rifle originated as a Canadian design, produced during the late-seventies NATO trials. The bottom two slots in the "birdcage" suppressor have been eliminated, thus forcing more gas upward through the remaining slots and aiding in keeping the muzzle down on burst fire. It also lessens the problem of water running into the bore off the channeling slot-edges, and doesn't kick up a blast of sand when fired from the prone position.

2. The barrel is heavier and, as noted by the Marines, suitable for use with the new, heavier-bullet M855 ammunition. The rifling twist has been tightened from the old 1-in-12 to FN's recommended 1 turn in 7 inches, and, in a move perhaps just a little wiser than many have credited, the extra six ounces of weight have been put right where the Navy had recommended: "..if possible, the hottest barrel region..not covered by the handguards". The official reason for retaining the old contour under the handguards is to allow the continued use, without modification, of the M203 grenade launcher. In addition to contractor's identification and proof mark, the new barrels are marked "5.56 NATO 1/7" on the top center of the stiffened front portion.

3. The front sight is a square post, adjustable for elevation.

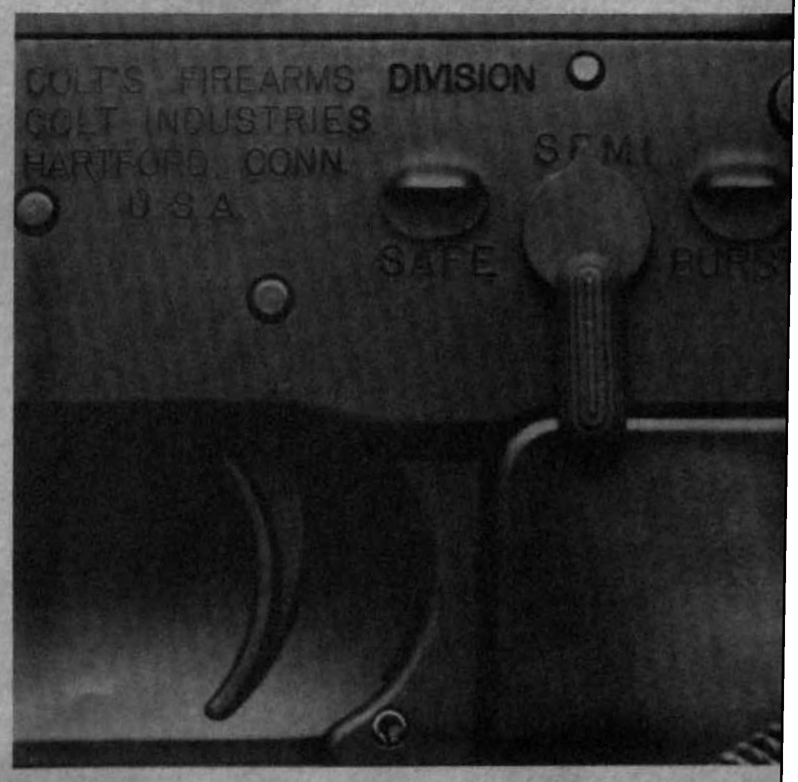
372. Closeup of receiver markings on early production version of the M16A2 rifle (8-million-series serial nos.) This is no. 8000031. Note the new, finger-grooved pistol grip.

4. The results of the Navy heavy-barrel firings were taken directly to heart in the design of the new handguards. These identical, and therefore interchangeable, ribbed top-and-bottom halves are much stronger and feature better heat dissipation than the old non-interchangeable left and right sides.

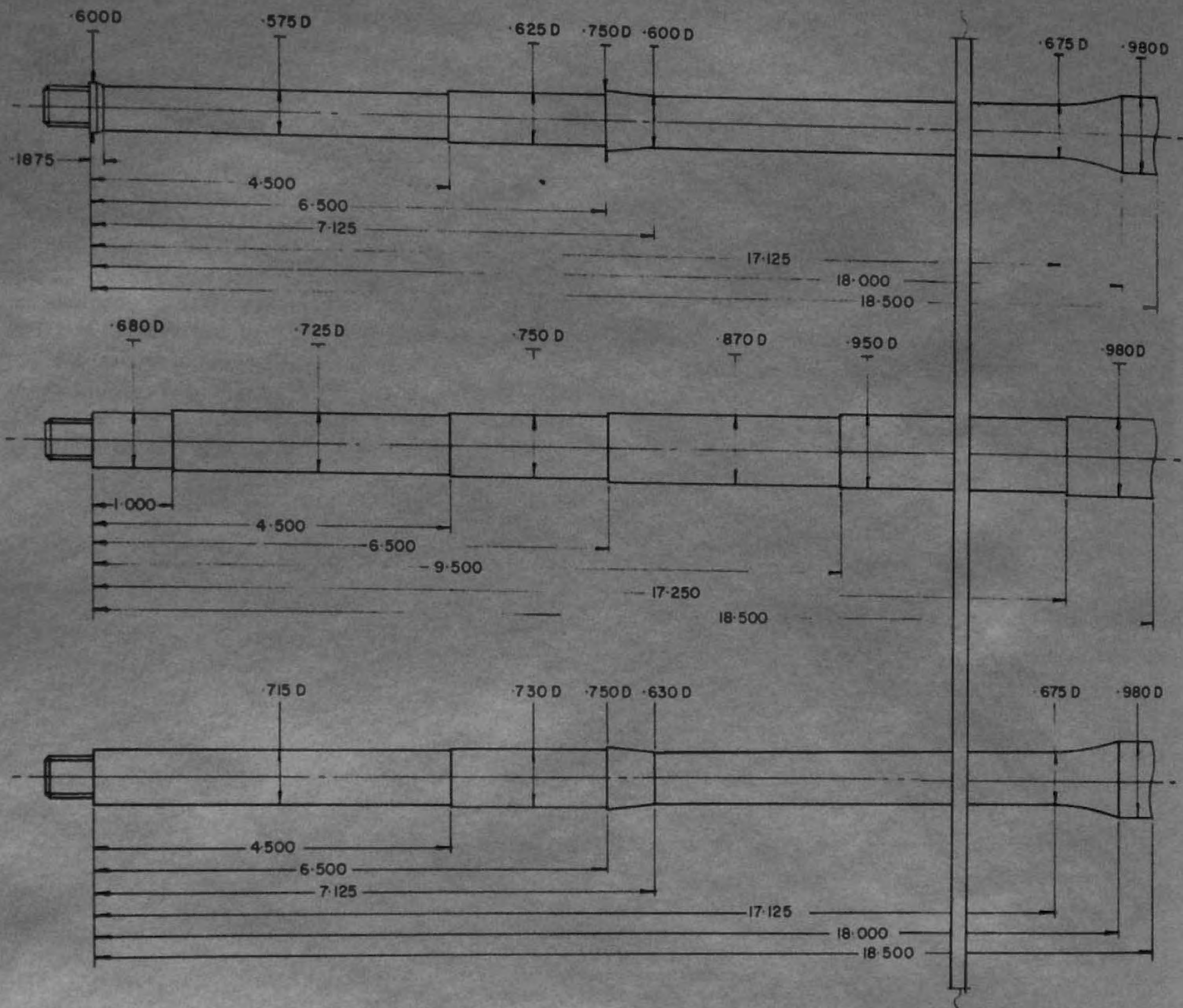
5. The circumference of the slip-ring or "delta ring" which secures the handguards at the receiver end has been canted for a better grip.

6. The upper receiver has been strengthened in the area surrounding its front attachment point with the lower receiver, and also features a distinctive, integral fired case deflector in the receiver wall behind the ejection port.

7. The rear sight has been completely redesigned. Its 1.75mm long range aperture is adjustable for windage and elevation, with a maximum range setting of 800 meters. A flip-up 5mm battle aperture is provided for ranges of 0 - 200 meters.



373. Closeup of selector markings on production M16A2 rifle.



374. A comparison of the major external dimensions of three barrels.
Above: standard M16A1.
Center: typical Colt HBAR.
Below: the controversial "heavy-front" M16A2, with under-the-handguard dimensions virtually identical to the M16A1 (above), to allow use of M203 grenade launcher. *Drawing by Thomas B. Dugelby*

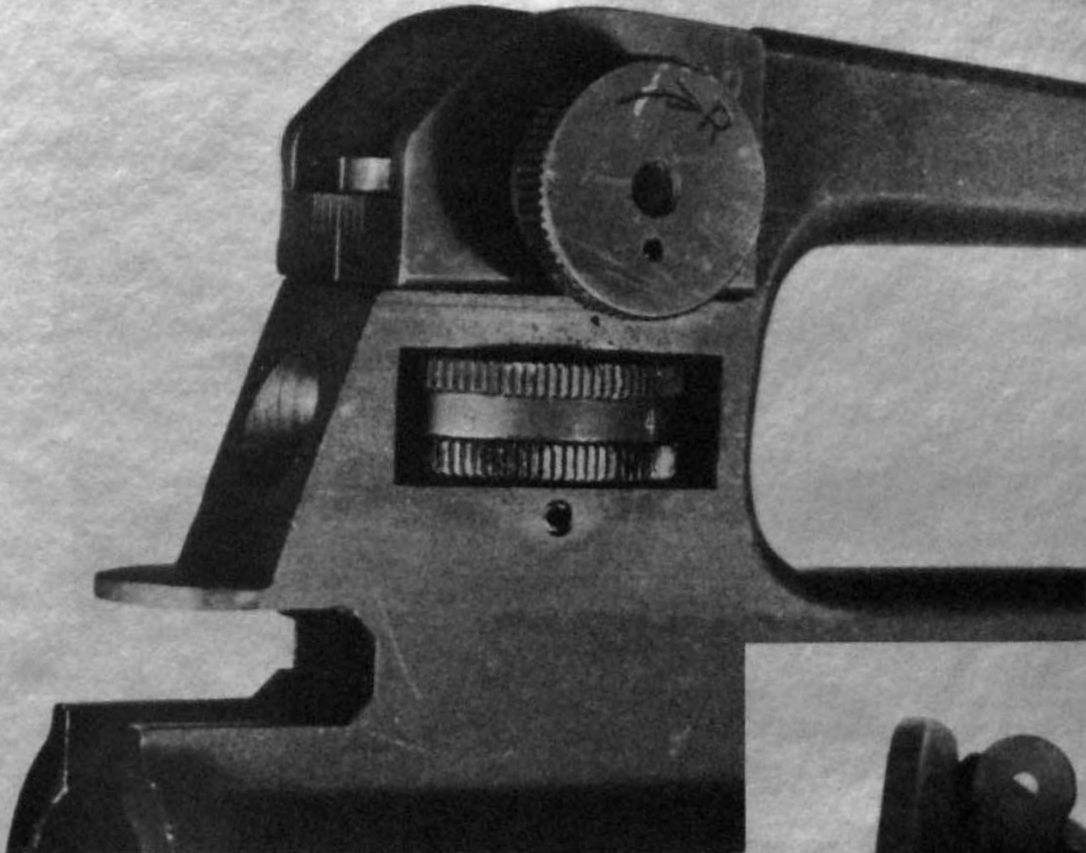
8. The forward assist thumbpiece, hitherto a ridged L-shape, now ends in a simpler-to-manufacture round button.

9. The pistol grip is made from stronger nylon with sharp checkering on the sides and a distinctive "swell" below the middle-finger position.

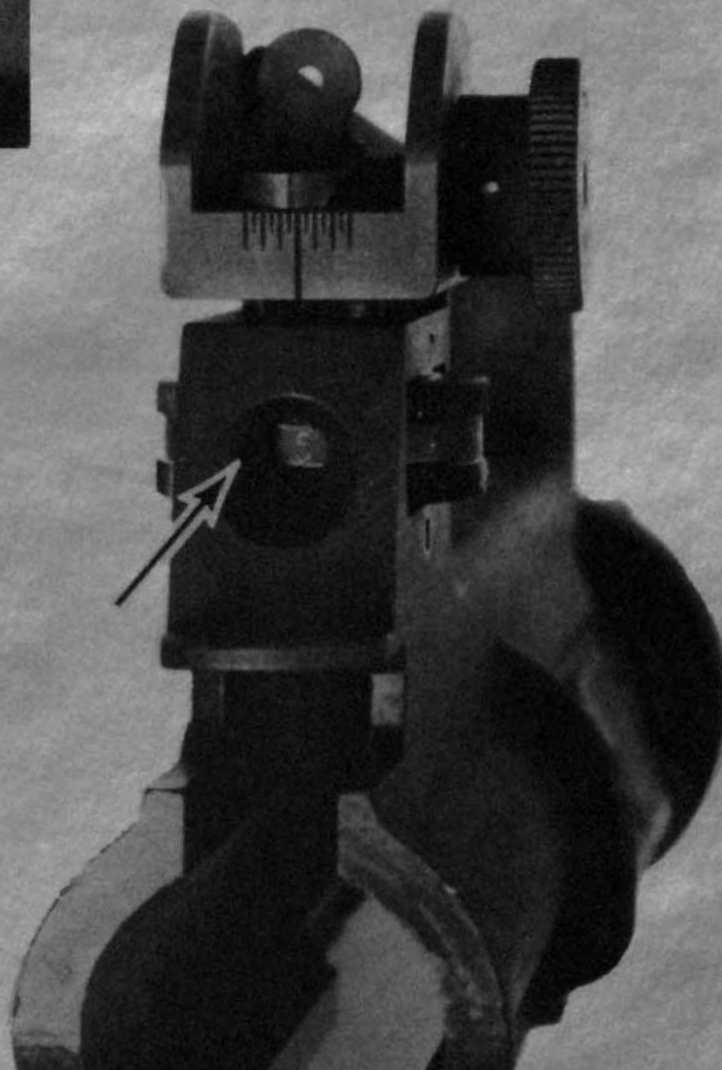
10. The change lever positions now read SAFE, SEMI and BURST: the Marine recommendation of a three-round burst feature to replace full-automatic fire has been incorporated in most models of the M16A2 "family".

11. The stock is made from foam-filled, super-tough nylon, said to be ten to twelve times stronger than the old fibrite stock, and is 5/8" longer.

12. The buttplate is squared and heavily checkered, and features a redesigned, easier-opening door to the internal storage cavity.



375. *Closeup views of the M16A2 rear sight, showing early windage knob (above). Note the 1.75mm long-range aperture and elevation set for 500 meters (arrow, below). Sight can be flipped forward to reveal 5mm battle-range aperture.*



The Colt 700-Series M16A2 Weapons Family

376. The Colt M16A2 Weapons Family as it originally appeared. From the top:
1. The M16A2 rifle (Colt model 711).
2. The M16A2 Carbine (Colt model 723, with lightweight barrel and injection-molded plastic buttstock).
3. The M16A2 "Commando" (Colt model 733).
4. The M16A2 HBAR (Colt model 741).
5. DOD was adamant that every M16-type rifle in the inventory should be capable of accepting the M203 grenade launcher attachment. Thus the uneasy compromise with the front-heavy barrel (fig. 374).
Courtesy Colt's Firearms Division

377. Closeup views of both sides of the receiver of a later M16A2 "Commando". Note the selector markings on both sides and the newer, chamfered rear sight windage knob (fig. 375).

As noted throughout this book, AR-15/M16 rifles had been assigned internal Colt (600-series, except for the short-lived, gas-pistoned model 703) model numbers since the inception of the program with the model (6)01. This was done mainly to ensure positive identification in the factory, due to the plethora of models with different features and/or markings Colt's produced.

Banking heavily on its future success and popularity, Colt's developed a complete M16A2 weapons family, the third since the CAR-15 system of the sixties. Perhaps as a measure of its departure from its predecessors, Colt's assigned new (700 series) model numbers to the new family:

Model	Description
701	Colt production version of the M16A2, described above.
703	An earlier, inadvertent use of the 700-series denominator (figs. 274-276). In an attempt to dramatize the differences in the model 703, Colt's had unofficially and fleetingly dubbed it the "M16A2". The M16A1 PIP program, described above, put the gas-pistoned Colt M703/"M16A2" firmly back on the shelf.
711	Same as the M16A2 except fitted with standard M16A1 sights and regular-weight M16A1 barrel.
723	The M16A2 "Carbine", fitted with a lightweight 14.5" barrel, M16A1 sights and telescoping (XM177E2-type) buttstock. Weight: 7 pounds.
733	M16A2 "Commando" version with 11.5" barrel, M16A1 sights, telescoping buttstock and standard M16A2 flash suppressor/muzzle brake.
741	M16A2 "HBAR": a magazine-fed, heavy-barrel squad automatic. Weighs just over 10 pounds.
715	Canadian Armed Forces rifle version of the M16A2, called in Canada the Rifle, C7. Discussed below.
725	Canadian Armed Forces carbine version of the M16A2, the C8.

The Critics Attack the M16A2's "Improvements"

The upshot of the PIP program, as we have seen, was to transform the M16A1 assault rifle, with its stated maximum range of 460 meters, into a full-scale, all-terrain main battle rifle with considerably improved range capabilities. As mentioned, during the 1978-1979 NATO trials the 5.56mm SS109 bullet had defeated the 3.5mm-thick NATO soft steel plate at 640 meters, a German helmet at 1,150 meters, and a US helmet at 1,300 meters; in every case better performance than with the 7.62 NATO round!

However, the criticisms and pronounced variations of opinion which have always surrounded the M16 continued to dog the heels of the M16A2. In an after-the-fact riposte to the list of "advantages" which the Marines had published following their tests of the PIP rifles, the Army-sponsored, Fort Benning-based Mellonics Systems Group argued powerfully and at length against virtually each and every modification:

[Mellonics Systems Development]

Memorandum for Record

The M16A2 Rifle

..The [USMC list of advantages of the M16A1E1 rifle (chapter 22)] represents the objective and subjective evaluation of Marine Corps personnel...To provide a balanced view, an additional analysis has been conducted from the point of view of Army training. It is not surprising that a different list of findings emerged. In fact, most..are in the form of a disadvantage or shortcoming...Also interesting to note is that there is very little direct conflict between items on the [USMC] list and the items listed below.

- The M16A2 does not have a sight setting for..25 meters, where zeroing and most practice firing occurs..

- The M16A2 does not have a setting for battlesight zero, i.e. 250 meters..

- ..the 5mm aperture used for 0-200 meters is probably too large and the 1 3/4mm aperture used for 300-800 meters is probably too small..

- The M16A2 sighting system is too complex..

- The M16A2 has less combat capability due to the elimination of full automatic fire [which] enhances the ability..to clear and defend buildings, to conduct final assaults on enemy positions, to defend against an enemy final assault, to conduct [or] react to an..ambush, to engage an enemy helicopter or fast-moving vehicle, etc. While the Marines claim greater accuracy and conservation of ammunition for the 3-round burst control, no data were generated during the [M16A1E1] test to support these contentions and no supportive data are known to exist...To be given very serious consideration is the fact that the burst control requires nine (9) new parts in the lower receiver..

..One of the reasons we acquired the M16 was because soldiers in combat felt they were being outgunned by an enemy armed with a full automatic AK-47...The psychological impact of full automatic fire can often make the difference in the unit's perception of how effective their fire is...It has been well established that, during World War II and Korea, up to 85% of soldiers failed to fire their semi-automatic weapons during some enemy contacts. In Vietnam, armed with a full automatic weapon, almost all soldiers returned fire. While much of the Vietnam firing was "wasted", i.e. it didn't hit anybody, it was a rare exception when individuals or units got into trouble because they had expended all of their available ammunition.

..The soldiers in Vietnam were not trained to employ rifle fire effectively. But it was not a one-bullet-for-one-kill environment. Most firing was directed at unseen targets...Whether or not the full automatic rifle really made any difference, soldiers thought it did...We must also carefully consider the fact that all potential enemies we will face have individual weapons with full automatic capabilities.

..During the limited research we have conducted in automatic fire - experimenting with burst size, various holding positions, etc. - we are finding that three-round bursts may not be the optimum burst size. In the majority of bipod-supported automatic rifle..positions, firing up to five and ten round bursts, the third round will many times find the limit of the group size with subsequent rounds moving back in toward and around the initial aiming point..

..It also is important to note that the..three-round burst control on the M16A2 does not recycle, i.e., if one or two rounds are fired because the trigger is not held long enough, a magazine change is required, or in the event of a stoppage for any other reason, the next pull of the trigger will not result in a three-round burst, but will result in [the remaining] one or two shots being fired. In other words, even when the burst control is properly working, it may result in the firing of one, two, or three shots..

There are two primary arguments for the three-round burst control - it is more accurate and it conserves ammunition. The first claim..is not true. The second..is not supported by data...the first three rounds of a five-round burst will strike the same place as the rounds from a three-round burst ..since the the third round departs the barrel before the fourth round is fired. As for conserving ammunition, a thirty-round burst will result in..expenditure..in a little less than 2 1/2 seconds, and ten 3-round bursts can result in..expenditure.. in five seconds..

- The M16A2 "heavy barrel" is heavy in the wrong place. The problem with the M16A1 [was] a temporary bending of the barrel..from the stress of various firing positions causing bullet strike to vary, e.g., the difference between a bipod firing position and a position using a hasty sling will change the strike of the bullet at 300 meters by three or four feet or more. The "bending" takes place between the receiver and the sling swivel/bayonet stud. The M16A2 barrel is "heavy" only from the sling swivel to the muzzle - where it can have no effect on the bending problem..

- the new ammunition (XM855) cannot be fired in the current rifle (M16A1).

Further criticisms were voiced, centering mainly around the fast one-in-seven rifling twist of the M16A2's barrel. It was disclosed that the 1-in-7 had been chosen mainly because the longer, 64-grain bullet of the tracer version of the SS109 (called by FN the L110 and in the US the XM856) required a one-in-seven twist in order to stabilize properly. Such a twist had been therefore specified in the newly-adopted US 5.56mm Squad Automatic Weapon (SAW), the M249 (FN Minimi). A somewhat slower one-in-nine twist (such as had been used in the PIP and MTU trials) was belatedly advocated for the M16A2, a compromise which would have improved its performance with the hundreds of millions of rounds of stockpiled M193 ammunition.

The fast twist was also an instant candidate for two traditional bugbears of such barrels, fouling and erosion. The Marines had conducted only a limited, 6,000-round endurance and accuracy trial with their M16A1E1s, and the poor results turned in by the PIP rifles were largely attributed to "growing pains" in the fledgling XM855 ammunition production program.

However, they were sobering to contemplate:

Rifle	Ammunition	Group Extreme Spread (cm)		
		Start	3,600 rounds	6,000 rounds
M16A1	M193	19.03	18.73	17.73
M16A2	XM855	27.43	31.23	62.23

The Marines had noted that, upon completion of the test, a standard barrel straightness gauge went through 29 of the 30 M16A1s, but would not pass through 14 of the 30 M16A1E1s. An investigation showed that the offending barrels were straight enough, but each contained sufficient jacket-metal and powder fouling to stop the gauge.

In addition, there was the standard issue M261 .22 rim fire conversion unit, designed by Mr. John Foote and produced for military training use by Saco Defense Systems Inc., of Saco, Maine. The soft-lead bullets of the standard .22 LR were designed for a slow one-in-sixteen twist. On this issue the Mellonics report summed up:

..While there are many problems associated with firing the .22 bullet through the M16A1, fouling being one of them, it is an acceptable training alternative. It may not be possible to fire the .22 long rifle cartridge through the M16A2 barrel without excessive loss of accuracy or excessive fouling [fig. 438]..

Further Scrutiny of the Non-Recyclable Burst Device

As mentioned, the Marines were using their new M16A2s competitively. The reason for this sudden interest among Marine target shooters was noted somewhat dryly by Marine Maj. R. N. Jepperson in his October 1984 *Marine Gazette* article entitled "How Good is the Finest Service Rifle?":

..Interest in the M16A2 among Marine Corps competitive shooters increased greatly when it was announced that the 1984 divisional matches would be fired with the new weapon.

The 1984 USMC matches began as ordered, amid a flurry of attempts at some sensible zeroing instructions for the new sights which could be retraced if necessary. Meanwhile, Maj. Jepperson's interesting article reported on a brand-new phenomenon introduced by the M16A2's non-recyclable burst device:

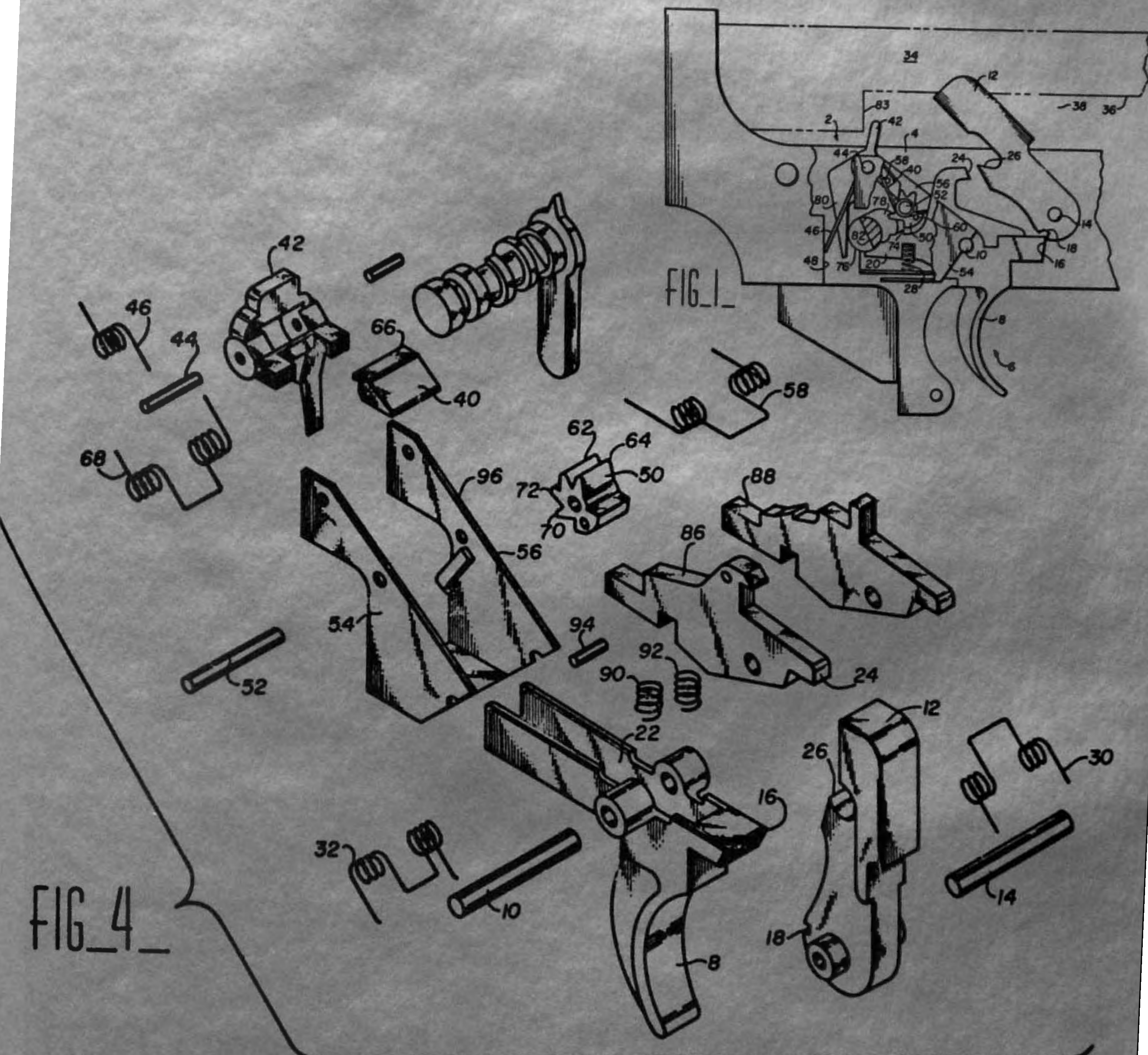
..My soaring optimism waned on the first day of firing, however, as I discovered a startling characteristic: three different trigger weights. This was something that news releases had not mentioned. Because of the burst control function of the trigger, the sear operates on a rotating cam device. The cam makes a complete rotation once for every three shots. Trigger weight gets progressively heavier for each shot until the cycle is finished..

..To get around this difficulty many..competitors..chose to "dry fire" two times after every slow-fire shot...This method was cumbersome, and time-consuming, and created occasional confusion - did I dry fire twice or three times? While.. acceptable during the slow fire stages, there was no escape during rapid fire. You simply had to be ready when the trigger squeeze was started in case it was lighter than anticipated..

Trigger Weights on 10 M16A2s

Rifle	*Stages*		
	1	*2*	*3*
1	*7.5*	*10.0*	*11.5*
2	*8.0*	*9.5*	*10.0*
3	*8.0*	*10.5*	*11.5*
4	*9.5*	*11.0*	*12.5*
5	*7.5*	*10.0*	*11.0*
6	*7.5*	*10.5*	*11.0*
7	*8.0*	*9.0*	*10.0*
8	*8.0*	*10.0*	*10.5*
9	*8.5*	*11.0*	*11.5*
10	*8.0*	*11.0*	*11.5*

The Proposed Snodgrass/Tyler Burst Control Device



378. It Can Be Done Department: figs. 1 and 4 from US Patent no. 4,004,496 entitled "M16A1 Burst Control", granted in 1977 to Robert E. Snodgrass and Michael N. Tyler. The patent's abstract reads "An automatically recyclable burst control mechanism..responsive to trigger action to actuate automatic recycling of the burst control mechanism to its initial position, independent of the number of rounds fired in each..burst". US Patent Office

"Enhancing" the M16A2

As noted, the modifications built into the M16A2 were largely USMC preferences. The Army waited until the spring of 1986 to announce a procurement contract with Colt Industries for 100,176 M16A2 rifles, at a unit cost of $479.16. Meanwhile, plans were begun in 1985 to "enhance" the M16A2 *before* any large numbers of them were produced for Army inventory.

Initially, the enhancement program had furthered earlier research which centered around the removal of the rifle's familiar carrying handle and replacing the standard iron sights with a reflex sight mounted directly on the top of the receiver (chapter 20). Colt's made up 50 "enhanced" rifles for trials. The excellent British Sight Unit, Small Arms, Trilux (the SUSAT; discussed in *Modern Military Bullpup Rifles*) and other telescopes and sighting systems were experimented with, all designed to offer the soldier a *single point of aim*. The night sights and non-magnifying collimator reflex sights (chapter 20) were also reviewed, but at the time of this writing no final decision has yet been made on the Army's M16A2 enhancement program.

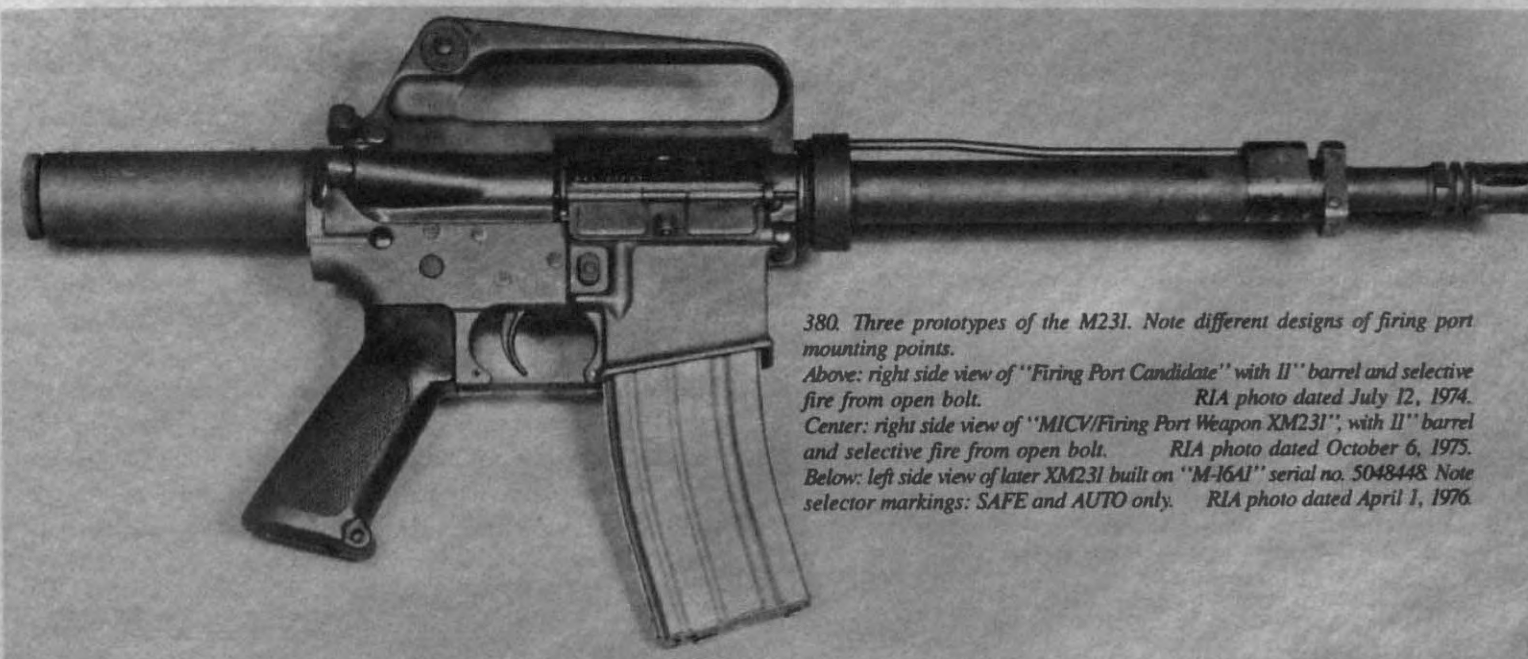
The Proposed Kodak Optical Sight System

379. Closeups of a civilian AR-15 (model SP1), fitted with experimental Kodak 3.5x Optical Sight.
Left: late model sight in Colt-adopted ARMS scope base.
Right: earlier model sight fitted with Kodak's 12-oz., slide-on "Night Adapter" with lithium-powered image intensifier, capable of presenting a 2x2-meter target area at ranges up to 500 meters. Note the early mount, which gave way to the ARMS design (above). Kodak has developed a unique insert-molding technique which imbeds polished but not edge-trued lenses, properly positioned, within the plastic body of the unit itself, thus dramatically reducing the cost of quality military optics.

The Special-Purpose M231 Firing Port Weapon (FPW)

During World War II it was painfully discovered that troops inside armored personnel carriers were vulnerable to close-in attack while inside their vehicles. The Germans even developed a modified MP44 *Sturmgewehr* featuring a curved barrel attachment called a *krummlauf*, which in conjunction with a periscopic sight allowed troops inside armored vehicles to bring small-arms fire to bear on anyone approaching the perimeter of the vehicle.

In May 1974, after a development/operational test of three candidate weapons (the M3A1 submachine gun, an M16A1 modified at Rock Island Arsenal, and a modified German 5.56mm HK33) the decision was taken to continue development of the Rock Island M16A1 at the Army's then-titled Research and Development Command

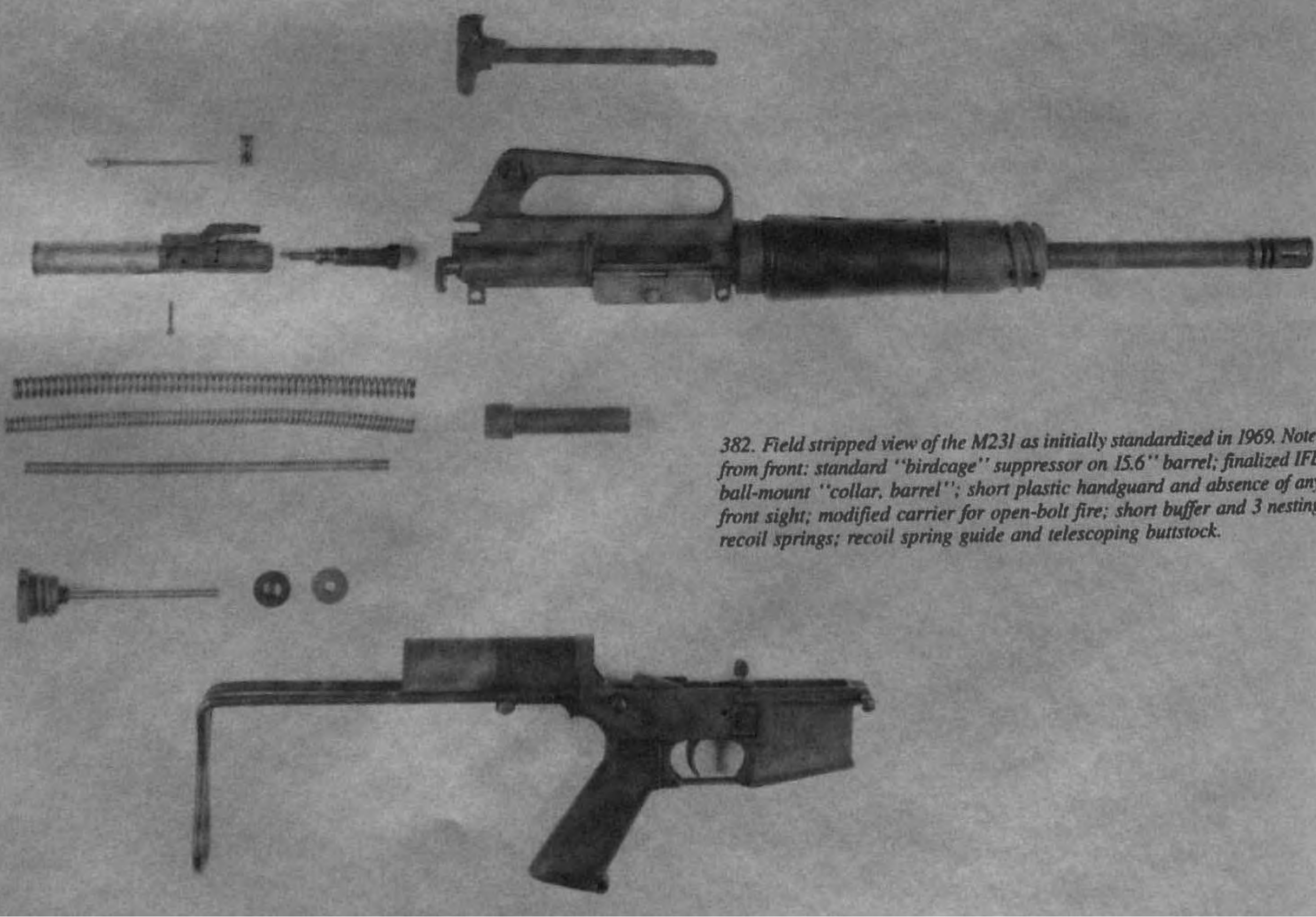


380. Three prototypes of the M231. Note different designs of firing port mounting points.
Above: right side view of "Firing Port Candidate" with 11" barrel and selective fire from open bolt. RIA photo dated July 12, 1974.
Center: right side view of "MICV/Firing Port Weapon XM231", with 11" barrel and selective fire from open bolt. RIA photo dated October 6, 1975.
Below: left side view of later XM231 built on "M-16A1" serial no. 5048448. Note selector markings: SAFE and AUTO only. RIA photo dated April 1, 1976.

381. A later prototype of the XM231 Firing Port weapon. Note the flip-up front sight; the short handguard; and the telescoping stock: all attempts to keep the weapon as versatile as possible in support of the short-lived "combat emergency mode" concept. RIA photo dated October 18, 1976

(ARRADCOM) in Dover, New Jersey. This weapon, subsequently christened the XM231, initially featured a short, heavy (11") barrel and internal changes which allowed selective fire from the open-bolt position, with a cyclic rate of 1,050 rpm.

Further changes led to the adoption of the full-auto-only M231, and a contract was signed with Colt's for the production of 27,000 FPWs as part of the standardization of the M2 Bradley Fighting Vehicle (BFV) in 1979. The finalized M231 is described as follows:



382. Field stripped view of the M231 as initially standardized in 1969. Note, from front: standard "birdcage" suppressor on 15.6" barrel; finalized IFB ball-mount "collar, barrel"; short plastic handguard and absence of any front sight; modified carrier for open-bolt fire; short buffer and 3 nesting recoil springs; recoil spring guide and telescoping buttstock.

overall length: 28.5 inches (723.9 mm)

weight: 8.5 lbs (3.8 kg) without magazine

barrel length: 15.6 inches (396 mm)

rifling: 1 turn in 12 inches

cyclic rate: 1,100 - 1,200 rpm

mode of operation: open-bolt fire; full automatic only

ammunition: M196 tracer only

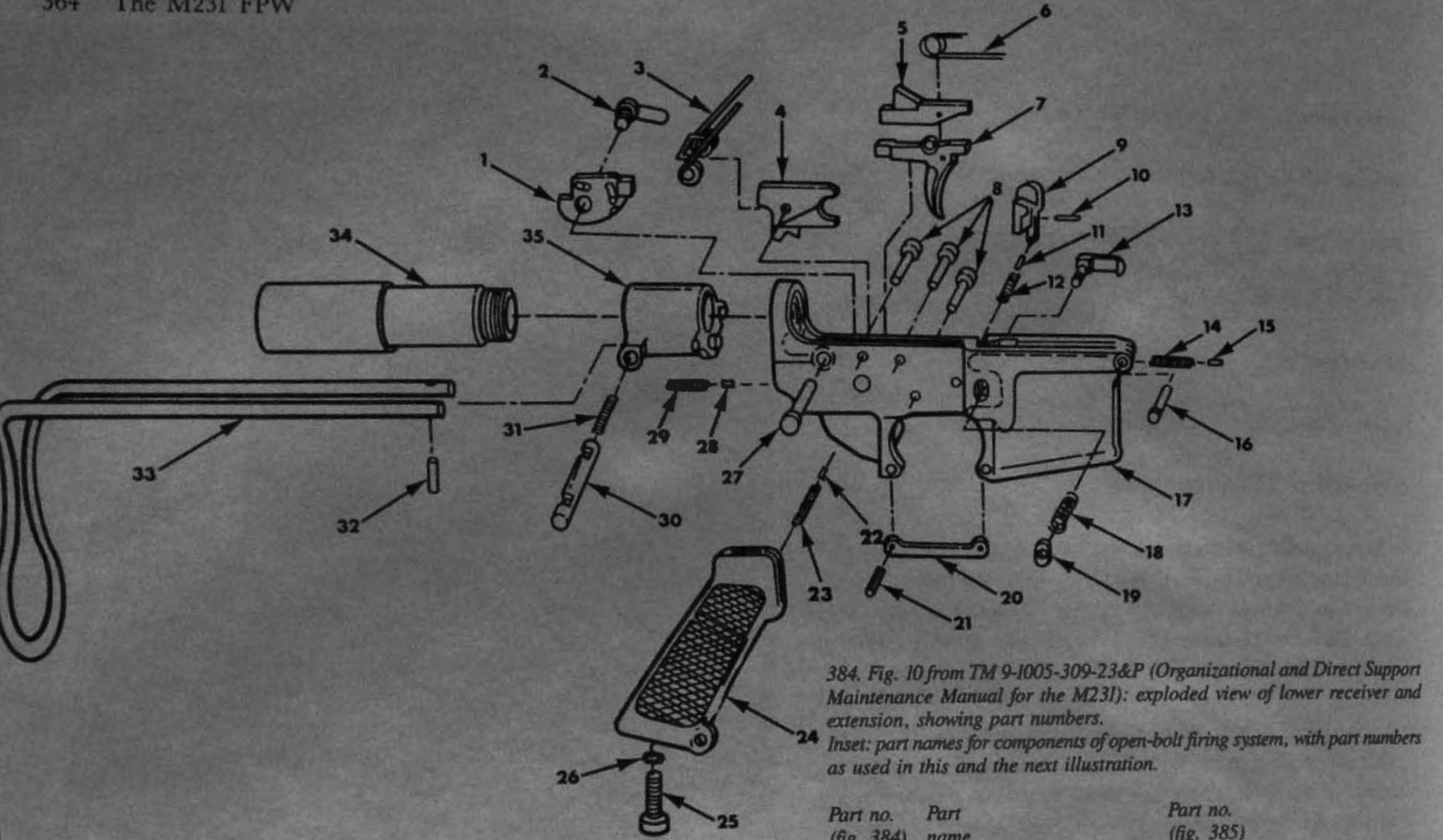
As originally standardized, the M231 featured a collapsible wire buttstock much like that of the M3A1 submachine gun, for use in the last-ditch, off-vehicle "combat emergency" mode. Latterly this feature has been done away with. As noted in a late correction to TM 9-1005-309-10:

> *The M231 FPWs will be fielded without buttstocks. TMs that accompany the FPWs will show the weapon with a buttstock, so don't think that your weapons are incomplete when you receive them...The weapon can be dangerous and ineffective when removed from a BFV. Without the buttstock, the muzzle climb..is difficult to control...The weapon is not authorized for off-vehicle use during training.*

Sixty-five percent of the M231 consists of standard M16A1 components. Other than the special barrel and quick-release collar, most modifications are internal. The hammer has been done away with, and the bolt carrier is modified with gas exhaust ports on the right side and a bent on the underside to allow it to catch and hold on the sear in the open position. When the trigger is pulled, the bolt and carrier go forward, stripping, chambering and locking on a round. A striker then impacts the floating firing pin, firing the round and beginning the action cycle. A redesigned return spring and buffer group, only 4.65" long, features three nested coil springs around a central guide rod.

383. A look inside the Bradley IFV, showing an M231 installed in ball-mounted firing port hole, and another in reserve (above). Photo courtesy Bob Faris

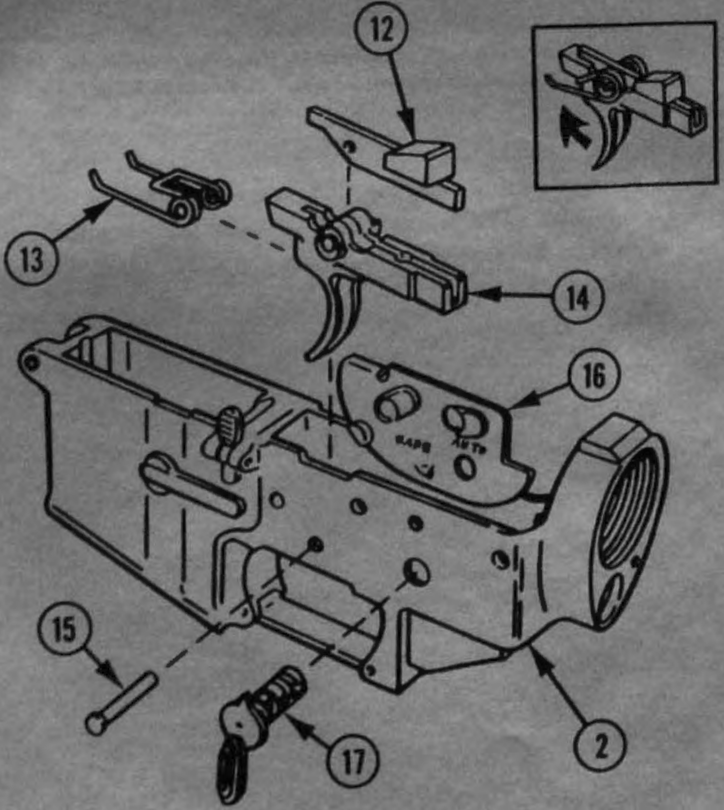
The M231 attaches quickly to the ball swivel mount in any of the BFV's six firing ports (fig. 383) and is intended for use exclusively with M196 tracer cartridges. The gunner aligns the weapon on the target without the use of sights by observing the bullets' trace and point of impact.

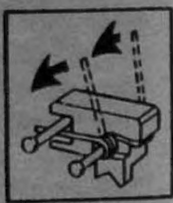


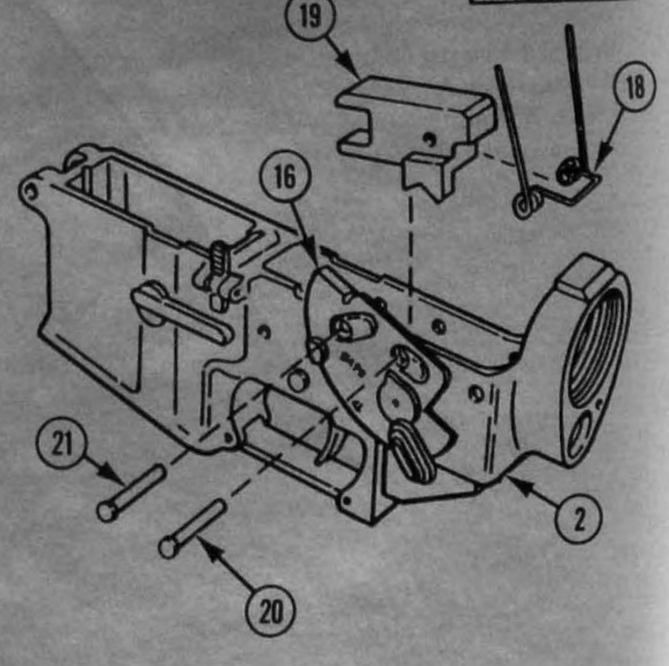
384. *Fig. 10 from TM 9-1005-309-23&P (Organizational and Direct Support Maintenance Manual for the M231): exploded view of lower receiver and extension, showing part numbers.*
Inset: part names for components of open-bolt firing system, with part numbers as used in this and the next illustration.

Part no. (fig. 384)	Part name	Part no. (fig. 385)
1	pivot pin retainer	16
2	selector lever	17
3	helical sear spring	18
4	sear	19
5	trigger extension	12
6	helical torsion spring	13
7	trigger	14
8	straight head pin	15,20,21

385. *Assembling the M231's lower receiver. (Refer to table, inset in fig. 384).*
Left: assembling trigger, trigger extension, pivot pin retainer (plate with selector markings), and change lever.
Right: assembling sear, helical sear spring, and their pins.

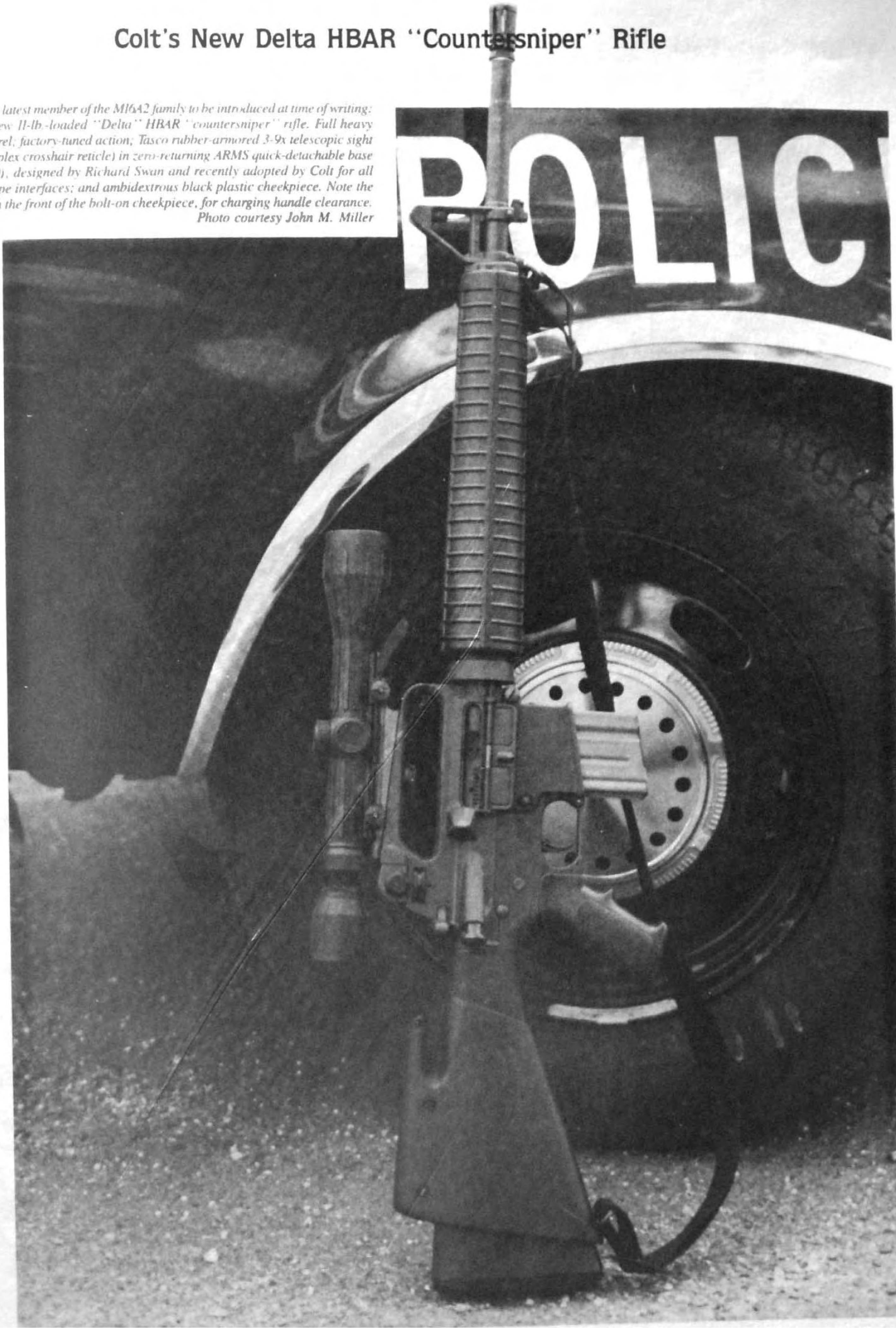






Colt's New Delta HBAR "Countersniper" Rifle

386. The latest member of the M16A2 family to be introduced at time of writing: Colt's new 11-lb.-loaded "Delta" HBAR "countersniper" rifle. Full heavy 20" barrel; factory-tuned action; Tasco rubber-armored 3-9x telescopic sight (with duplex crosshair reticle) in zero-returning ARMS quick-detachable base (fig. 379), designed by Richard Swan and recently adopted by Colt for all M16/scope interfaces; and ambidextrous black plastic cheekpiece. Note the cutout in the front of the bolt-on cheekpiece, for charging handle clearance. *Photo courtesy John M. Miller*



387. Above: Canadian Arsenals Limited (CAL) 7.62 NATO caliber C1A1 rifle, left side view. The standard Canadian service rifle from 1955 to 1984. Editor's collection

Below early selective fire "Rifle Auto 7.62 mm FN C2", the heavy-barrel, selective fire, light automatic weapon version of the C1. Note the fold-down handguard/bipod and 30-round magazine. The story of these arms is told in North American FALs.

Chapter Twenty four

THE CANADIAN C7 RIFLE - A REASONED VIEW FROM THE NORTH

A Look at the Canadian Arsenal

At the time of the 1978-79 NATO trials, the existing Canadian Forces small arms arsenal was listed under the following alpha-numeric descriptors:

C1 (and C1A1): the inch-measurement FN FAL rifle in caliber 7.62 NATO, as made during the '50s and '60s by the now-defunct Small Arms Division of Canadian Arsenals Limited (CAL) in Mississauga (Long Branch) Ontario. (The history, development and specifications of the C1/C1A1 rifle are described in detail in Collector Grade's *North American FALs*). Adopted in 1955; superseded in 1984 by the events described below.

C2 (and C2A1): basically the same as above only fitted for selective fire and featuring a heavy barrel, 1,000-meter sights and a folding handguard/bipod. The Canadian squad automatic weapon from 1955 to 1986.

C3: basically a commercial British-made, Parker-Hale 1200TX bolt-action rifle, in caliber 7.62 NATO. Used with telescopic or micrometer iron sights as a sniper rifle.

C4: the Canadian No.4 Mk.1* .303 bolt-action rifle (Lee-Enfield), still used by Ranger and cadet units.

C5: a modified M1919A4 7.62x63mm (.30-06) Browning machine gun, converted in Canada to fire belted 7.62mm NATO ammunition.

C6: the Belgian-made FN MAG (*mitrailleuse a gaz*), caliber 7.62mm NATO. Purchased by Canada in 1984 in four versions for use in and around the Canadian-adopted Leopard tank. Two models were equipped with bipod, buttstock and pistol grip: the infantry version with a flash eliminator and the "turret mounted" configuration with a plain muzzle. The two other versions were purchased without butt or bipod; one being mounted coaxially with the Leopard's main gun, and the other an ARV version with a special adjustable gas system.

With the demise of the Small Arms Division of Canadian Arsenals Limited (CAL) in June of 1976, the private-sector firm Diemaco, Incorporated of Kitchener, Ontario contracted with the Canadian government to establish a facility to support the existing small arms inventory, described above, and to provide the necessary engineering backup and eventual production facilities if and when it was decided to replace the existing weapons with a new family of small arms.

Canada and the "Weapons of the Eighties" NATO Trials

While fielding no new weapons or ammunition of its own, Canada had conducted the low temperature and climate evaluation portion of the 1978-79 NATO trials. This included complete responsibility for a major two-month Winter Trial of all competing weapons (average daily temperature -35° Celsius) during early 1979. Additionally, 37 examples of each of the weapon types listed in chapter 22 were provided to the Canadian government for study in a series of summer and winter military trials plus endurance, precision and adverse-condition tests. The Canadians found that the 5.56mm entries were generally more accurate than their existing 7.62mm weapons.

Chapter Twenty four

THE CANADIAN C7 RIFLE - A REASONED VIEW FROM THE NORTH

A Look at the Canadian Arsenal

At the time of the 1978-79 NATO trials, the existing Canadian Forces small arms arsenal was listed under the following alphanumeric descriptors:

C1 (and C1A1): the inch-measurement FN FAL rifle in caliber 7.62 NATO, as made during the '50s and '60s by the now-defunct Small Arms Division of Canadian Arsenals Limited (CAL) in Mississauga (Long Branch) Ontario. (The history, development and specifications of the C1/C1A1 rifle are described in detail in Collector Grade's *North American FALs*). Adopted in 1955; superseded in 1984 by the events described below.

C2 (and C2A1): basically the same as above only fitted for selective fire and featuring a heavy barrel, 1,000-meter sights and a folding handguard/bipod. The Canadian squad automatic weapon from 1955 to 1986.

C3: basically a commercial British-made, Parker-Hale 1200TX bolt-action rifle, in caliber 7.62 NATO. Used with telescopic or micrometer iron sights as a sniper rifle.

C4: the Canadian No.4 Mk.1* .303 bolt-action rifle (Lee-Enfield), still used by Ranger and cadet units.

C5: a modified M1919A4 7.62x63mm (.30-06) Browning machine gun, converted in Canada to fire belted 7.62mm NATO ammunition.

C6: the Belgian-made FN MAG (*mitrailleuse a gaz*), caliber 7.62mm NATO. Purchased by Canada in 1984 in four versions for use in and around the Canadian-adopted Leopard tank. Two models were equipped with bipod, buttstock and pistol grip: the infantry version with a flash eliminator and the "turret mounted" configuration with a plain muzzle. The two other versions were purchased without butt or bipod; one being mounted coaxially with the Leopard's main gun, and the other an ARV version with a special adjustable gas system.

With the demise of the Small Arms Division of Canadian Arsenals Limited (CAL) in June of 1976, the private-sector firm Diemaco, Incorporated of Kitchener, Ontario contracted with the Canadian government to establish a facility to support the existing small arms inventory, described above, and to provide the necessary engineering backup and eventual production facilities if and when it was decided to replace the existing weapons with a new family of small arms.

Canada and the "Weapons of the Eighties" NATO Trials

While fielding no new weapons or ammunition of its own, Canada had conducted the low temperature and climate evaluation portion of the 1978-79 NATO trials. This included complete responsibility for a major two-month Winter Trial of all competing weapons (average daily temperature -35° Celsius) during early 1979. Additionally, 37 examples of each of the weapon types listed in chapter 22 were provided to the Canadian government for study in a series of summer and winter military trials plus endurance, precision and adverse-condition tests. The Canadians found that the 5.56mm entries were generally more accurate than their existing 7.62mm weapons.

With the H&K caseless G-11 withdrawn due to cook-off problems, and the British "bullpup" 4.85x49mm XL series losing points due to its non-standard caliber and appearance, the contest narrowed to a comparison between the Belgian FNC and the US M16A1. (The Dutch MN1, while also firing the 5.56mm cartridge and described as an Israeli Galil, was in reality little more than a "laundered" AK-47 and as such was deemed unsuitable politically.) The result was that while both the M16A1 and the FNC featured equivalent hit probability, the M16A1 was significantly more reliable and was the overall preference of the troops involved in the trials.

The Small Arms Replacement Program (SARP)

388. First-off C7 rifle, serial no. 85AA00001, from initial run of 21 pre-production weapons. Presented to Commander Force Mobile Command Lt. Gen. C. H. Belzile, CMM, CD on November 12, 1985. Type 2 receiver markings (fig. 389). Courtesy Small Arms Replacement Program (SARP) Ottawa

With the 1980 NATO adoption of the 5.56x45mm in the Belgian SS109 version (or equivalent, such as the American XM855), the Canadian government granted a $1.7M contract to Diemaco in February 1983 for a small arms replacement program (SARP) to supersede Canada'a ageing arsenal of 7.62mm rifles and squad automatics with new weapons in 5.56mm caliber. Thus the above list of descriptors was added to, as follows:

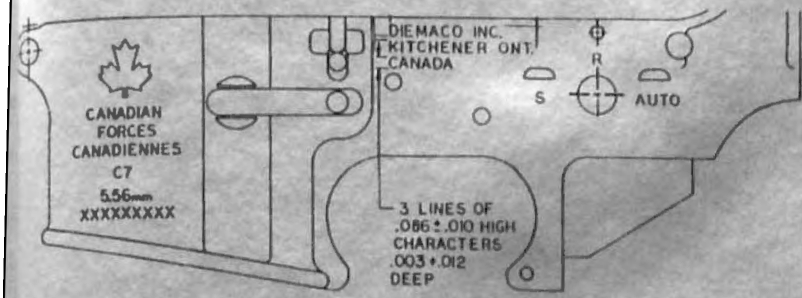
C7: the Canadian version of the Colt M16A2, but with some differences, as described below. The government contracted for 79,935 C7 rifles.

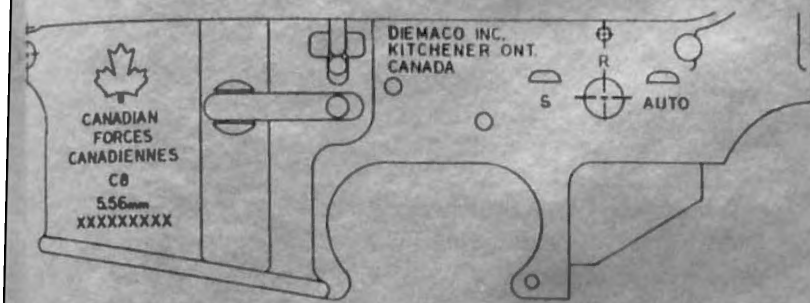
C8: a carbine version of the C7, of which 1,565 were ordered. The C8 is fitted with an XM177E2-style collapsible buttstock and weighs 1.3 pounds (.6 kg) less than the C7. With its stock telescoped, it is 29 cm (11.5") shorter overall. The C8 boasts 86% parts commonality with the C7 rifle.

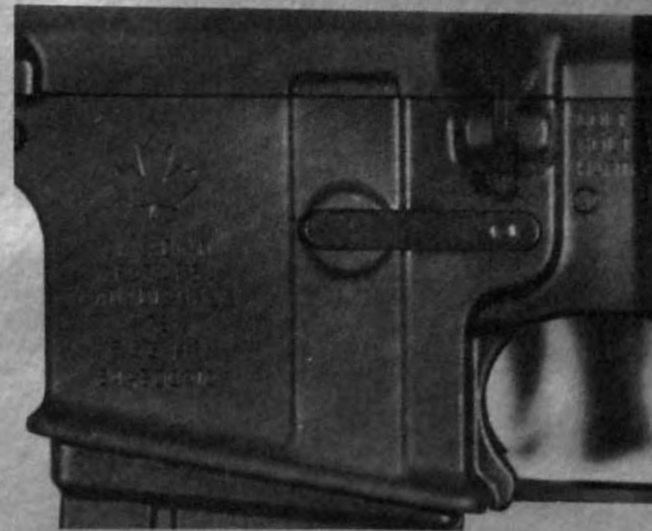
C9: As mentioned, the NATO guidelines for the '80s called for individual and light support weapons (IWs and LSWs) in the same "second" caliber, backed up by medium weapons in 7.62 NATO. This plan was fully supported by the results turned in by the FN SS109 version of the 5.56x45mm cartridge.

Accordingly, the Canadians rounded out their new family of small arms by purchasing 6,500 slightly modified examples of the FN Minimi (*mini-mitrailleuse*) light machine guns from Fabrique Nationale. Interestingly, the C9's flash suppressor began as the same 5-slotted Canadian design already adopted in both the US M16A2 and the Canadian C7, but with the further omission of the topmost gas slot in order to minimize flash signature and consequent night vision degradation. These special flash suppressors were manufactured in Canada and shipped to FN Herstal for final assembly.

A mutual arrangement exists whereby Diemaco manufactures some return receives some other M249 (Minimi) components from FN's US operation FN Manufacturing, Inc. (FNMI) of Columbia, South Carolina.)







389. Three types of receiver markings used so far on the Canadian C7 Rifles and C8 Carbines.
Type 1: initial style proposed for C7 Rifle and C8 Carbine; not adopted.
Type 2: markings on Colt-made C8 trials receiver (Colt model 725), serial no. 84AB00010. Note standard "Colt's Firearms Division" maker's legend (right).
Type 3: current style; adopted. Note Diemaco logo and selector markings S, R, AUTO.

In addition to these new weapons, the February 1983 contract called for the supply of 470,570 nylon 30-round C7/C8/C9 magazines, 51,975 blank-firing adaptors and bayonets for the rifles, all to be produced in Canada.

A Comparison Between the C7 and the M16A2

As noted, the C7 is essentially a Colt M16A2 with some modifications and omissions. It is officially described as follows:

length overall: 100 cm (40")

weight, loaded (30 rounds): 3.8 kg (8.4 lbs)

caliber: 5.56mm NATO

rifling: 6 grooves, right hand; 1 turn in 17.8cm (7")

muzzle velocity: 920 m/sec (3,018 fps)

cyclic rate 700-940 rds/min

effective range: 400 meters

maximum range: 600 meters.

Beginning at the front end, the chief differences between the two weapons are as follows:

barrel: the C7 shares the controversial "heavy-in-the-wrong-place" profile of the M16A2; more controversial in Canada perhaps even than in the US as the Canadians do not use the M203 grenade launcher, and thus the official US reason for retaining the M16A1 dimensions under the handguards of the M16A2 does not apply. In fact, Canada actually proposed a more conventional heavy barrel profile and applied for a design concession on the M16A2 barrel contour, which Colt's refused to grant. The C7's hammer-forged barrel also shares the tight 1-in-7 rifling twist, necessary to stabilize the Canadian version of the NATO-adopted SS109 bullet, called the C77.

sights: like the M16A2, the C7 front sight is described as a "square prism on a threaded base", but in view of the 400-meter (600 meter maximum) Canadian range requirement the M16A2's "complex" 800-meter rear sight was considered unnecessary. Consequently, the C7 features a standard 2mm- and 5mm-aperture M16A1-type flip sight.

390. Left and right side views of an interesting cutaway instructional C7 rifle (Colt model 715). Type 2 receiver markings (fig. 389).

391. C7 and C8 barrels are made on this government-supplied, state-of-the-art hammer forge from GFM of Austria, the only one of its kind in Canada. This powerful machine takes a carefully honed, smoothbore "blank" (below) and exerts tons of pressure on the outside surface in a continuous and extremely rapid multi-hammering process, drawing the blank out roughly one-and-a-half times its original length and cold-forging it down around a hardened mandrel. The mandrel, about six inches long, is perfectly formed in the shape of the chamber, leed and the first few inches of rifling. Concentrating initially on the rifling section, the blank is slowly rotated as it is hammered, the mandrel being simultaneously withdrawn until the end of the blank approaches, whereupon the mandrel stops while the hammers continue, thus cold-forming the complete bore and chamber configuration all in one pass.
Courtesy Small Arms Replacement Project (SARP) Ottawa

firing mode: Canada's only other selfloading rifle, the C1/C1A1, was predominantly issued as a semi-automatic during the whole of its thirty-odd years of service, and Canadian Forces doctrine stressed semi-auto fire only except under "special circumstances". Full-auto fire discipline was considered to be "a function of training, and not accomplished by some add-on device or gadget". Therefore the M16A2's 3-round burst device, already viewed as more expensive and less reliable than the standard selective fire mechanism, was deemed "not required". Canadian-made C7 and C8 selector markings read S, R and AUTO.

magazine: Canada will build no 20-shot magazines, and has standardized on a fifth-generation, Canadian-made nylon 30-round magazine. Another outcome of the 1978-1979 NATO trials was the standardization of the interface of the M16A1's 30-round magazine for all 5.56mm IWs and magazine-fed LSWs henceforth adopted within the organization. The nylon 30-round C7 magazine will consequently fit all such weapons: the C7, the C8 *and* the C9 (M249; Minimi); the British L85A1, the M16 family, and so on.

buttstock: another commendable tradition that has survived in the Canadian forces for many years, in an effort to best "tailor" rifles to their variously-sized users, has been the availability of different buttstock lengths. Canadian No.4 rifle buttstocks were produced in long (L), normal (N), short (S) and bantam (B) lengths; and the C1A1 was available fitted with extra-long (XL), long (L), normal (N) and short (S) stocks. Noting that the M16A2 featured a stock 5/8" longer than that of the old M16A1, Canada followed suit but stipulated that an optional 1/2" spacer be made available, so that the C7 will continue the tradition of user-variable buttstock lengths.

butt trap: the C7 will use a modified door developed by Colt's which can be more readily opened than that of either the M16A1 or the A2.

392. *Canadian Forces 5.56mm C7 rifle and C9 (FN Minimi) light machine gun, with equipment. Type 3 receiver markings (fig. 389). Note the ammunition supply packaging: 30-round Canadian-made nylon magazines are charged from plastic 10-round charging clips pre-loaded in 60-round bandolier (foreground); para-droppable crate holds 20 bandoliers (1,200 rounds) of C77 ball ammunition. Note Canadian stainless-steel bayonet (fig. 429).*

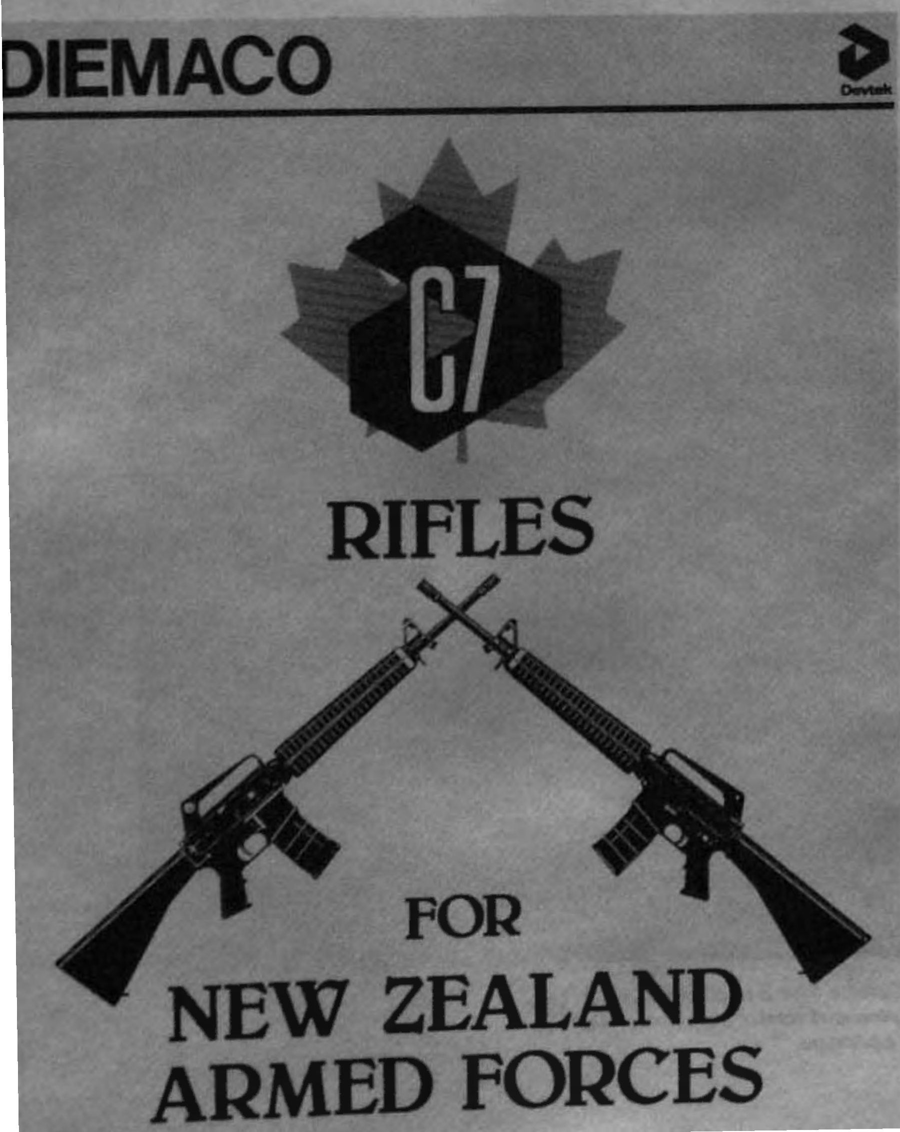
393. *Canadian Forces trials C8 Carbine (type 2 receiver markings). Used exclusively by tank and armored personnel carrier (APC) crews, the C8 is here surrounded with associated equipment.*

Canadian Production of the C7 Rifle and C8 Carbine

In order to commence manufacture of the C7, once all the details regarding the rifle's configuration and the production licence had been thrashed out, a number of rifles and carbines were initially made up to the Canadian pattern at Colt's in Hartford, designated models 715 and 725 respectively. Ironically, here the Canadians found an extra item on the bill from Colt's: a fee to "re-engineer" the receiver back to the old A1 fixed-rear-sight configuration!

After the Colt-made 715s and 725s had passed Canadian acceptance trials, a five-phase plan was instituted which designated five stages of increasing Canadian content in the manufacturing process. During these phases, components of non-Canadian manufacture are supplied by Colt's.

395. As a part of Diemaco's licensed production contract with Colt's, the Canadian firm was granted manufacturing and export rights to the C7 rifle in Southeast Asia: hardly an unexplored market by the 1980s, as we have seen. Nevertheless in May, 1986 Diemaco did prepare this short-lived proposal for the supply of Canadian-built C7 rifles, modified to suit, to the New Zealand Armed Forces. (New Zealand has since followed the Australian lead in adopting the Austrian-designed Steyr AUG rifle [Modern Military Bullpup Rifles], *and the FN Minimi). Courtesy Diemaco, Inc.*

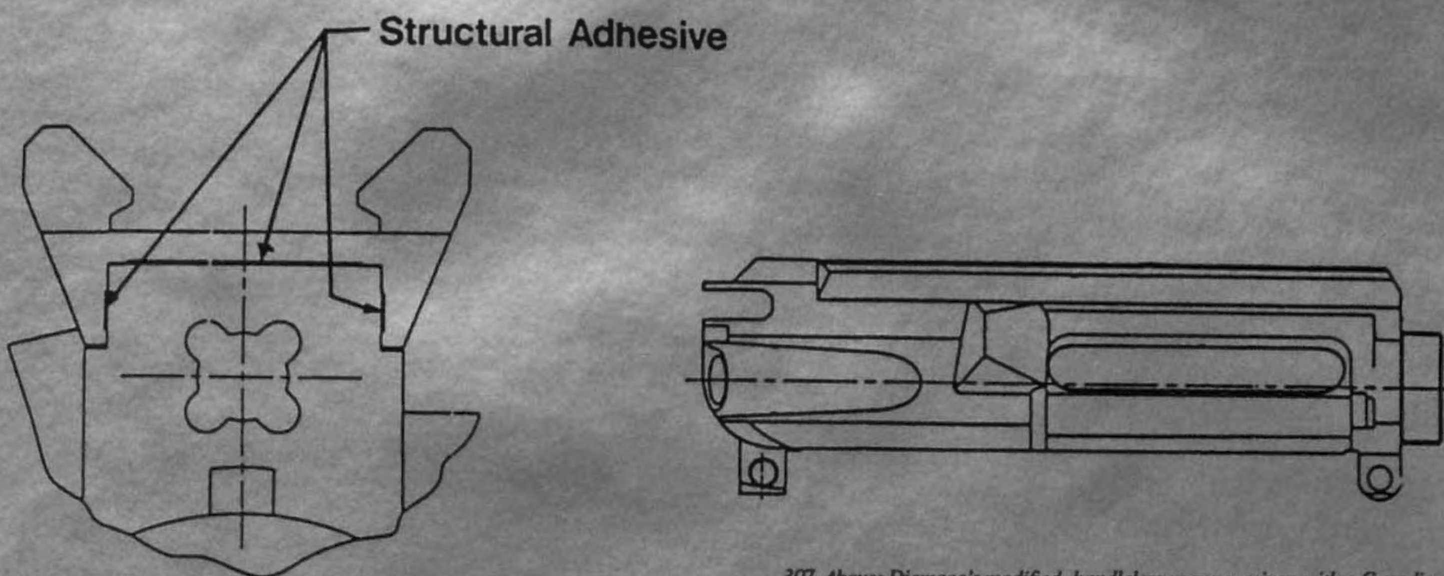


394. Markings on C7 rifle barrel: C MP 5.56 NATO 1/7.

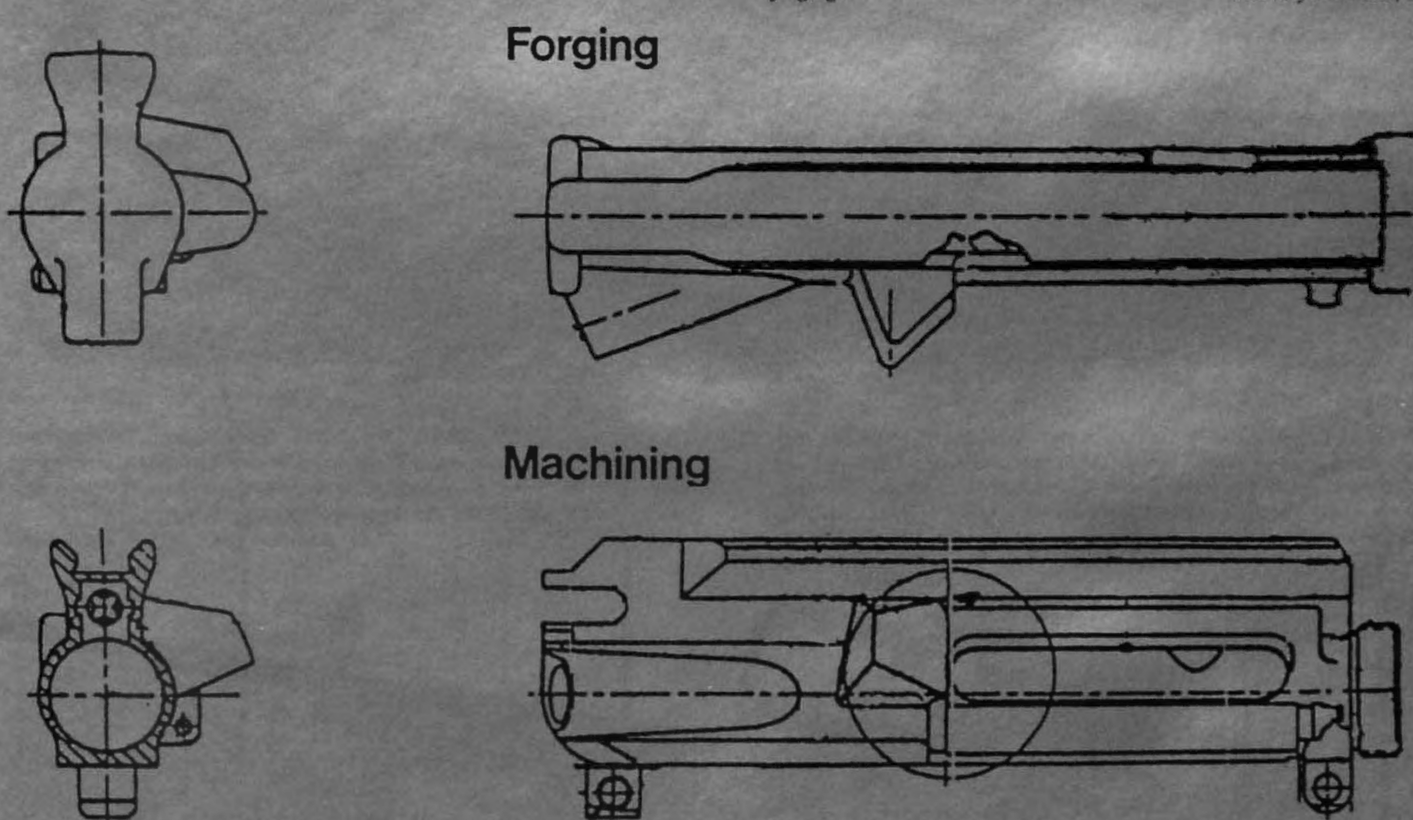
Diemaco delivered pre-production "phase 1" rifles on schedule in August 1985, which successfully passed acceptance. Production deliveries to selected units were scheduled to begin in March 1986, against a continuing program designed to retire the last C1A1s in mid-1992.

The fifth phase, 100% Canadian production, is supposed to be in place and operating by March of 1988, and at the point of this writing (July 1986) it is understood that Diemaco is well ahead of this schedule. Eventually, Diemaco will manufacture 17 critical components in-house and sub-contract (in Canada) for the rest of the parts of the C7/C8 weapon system.

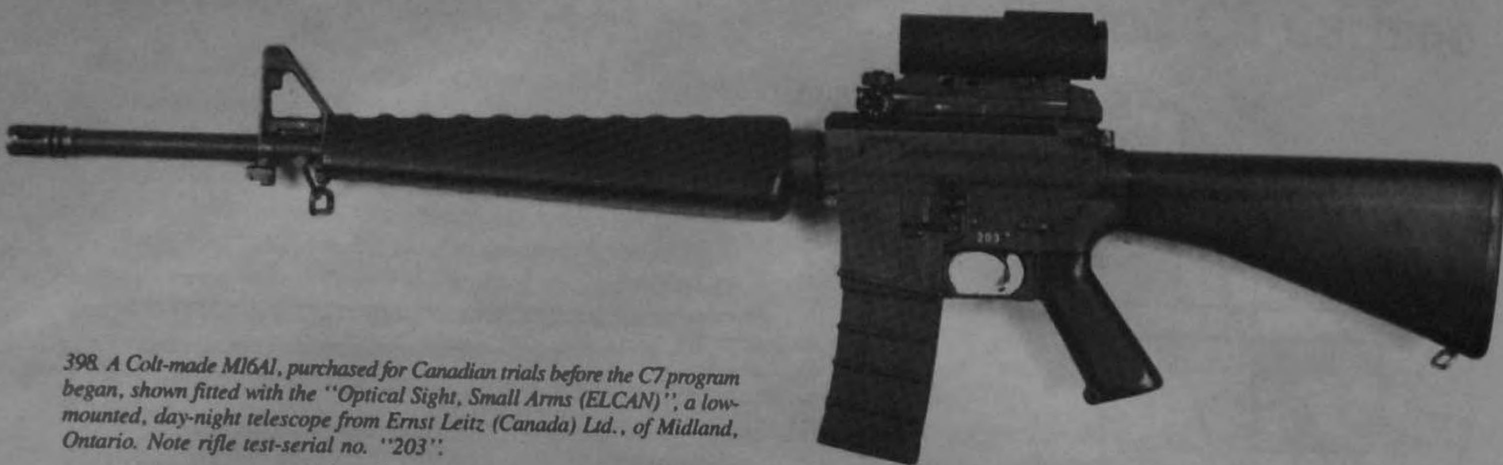
396. A Colt trials model 715 rifle, modified in Canada for low-scope mounting. Canada initially tested a number of sight-enhancement devices for its new 5.56mm weapons which did not *require weapon modification. These included standard Colt/Realist 3- and 4-power telescopes; a 1-power, battery-powered, front-sight-mounted holographic dot projector (the "H.R.S.100"); the "Hiteye 1500", a 1.5-power, ring-reticle telescopic sight, also mounted in the carrying handle; and tritium-filled iron sights. A later Diemaco "enhancement" program examined a number of sighting systems fitted to this Canadian-designed handle-less upper receiver (fig. 397).*



397. Above: Diemaco's modified, handleless upper receiver, with a Canadian-designed scope base bonded on to provide a "universal interface channel", allowing the use of any telescope by means of a simple adapter plate. Below: If the universal handleless receiver "flew" (which to date it hasn't), Diemaco foresaw its manufacture from "scratch" in this proposed machined forging. *Courtesy Diemaco, Inc.*



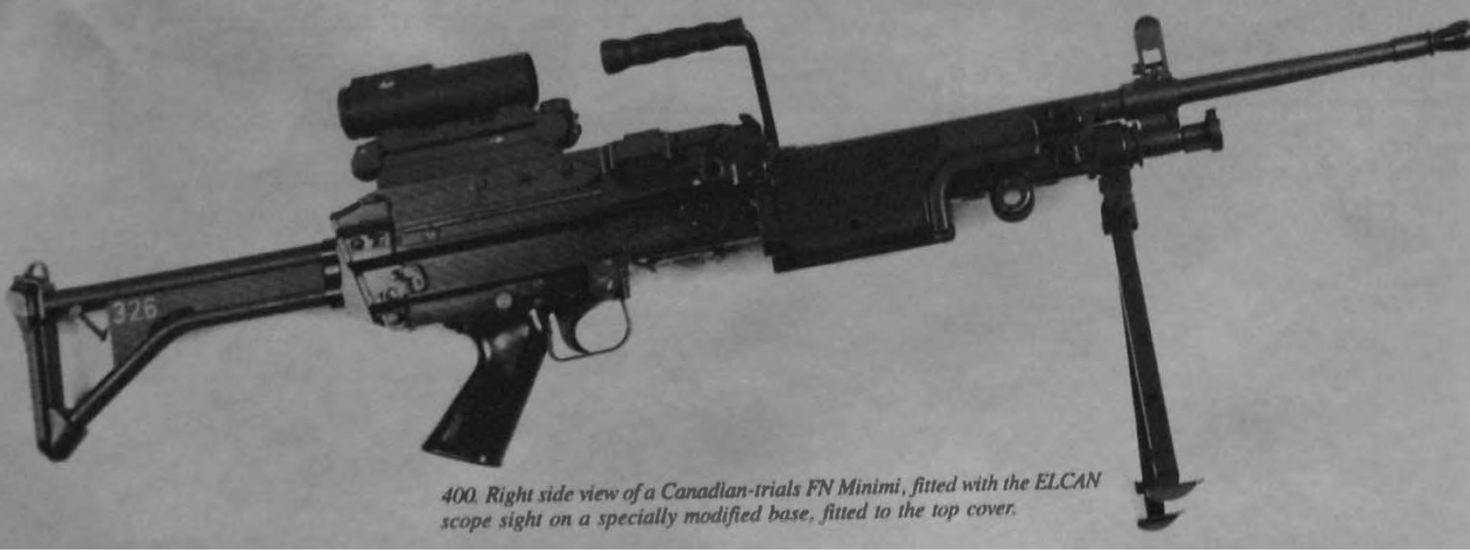
The Leitz "Optical Sight, Small Arms (ELCAN)"



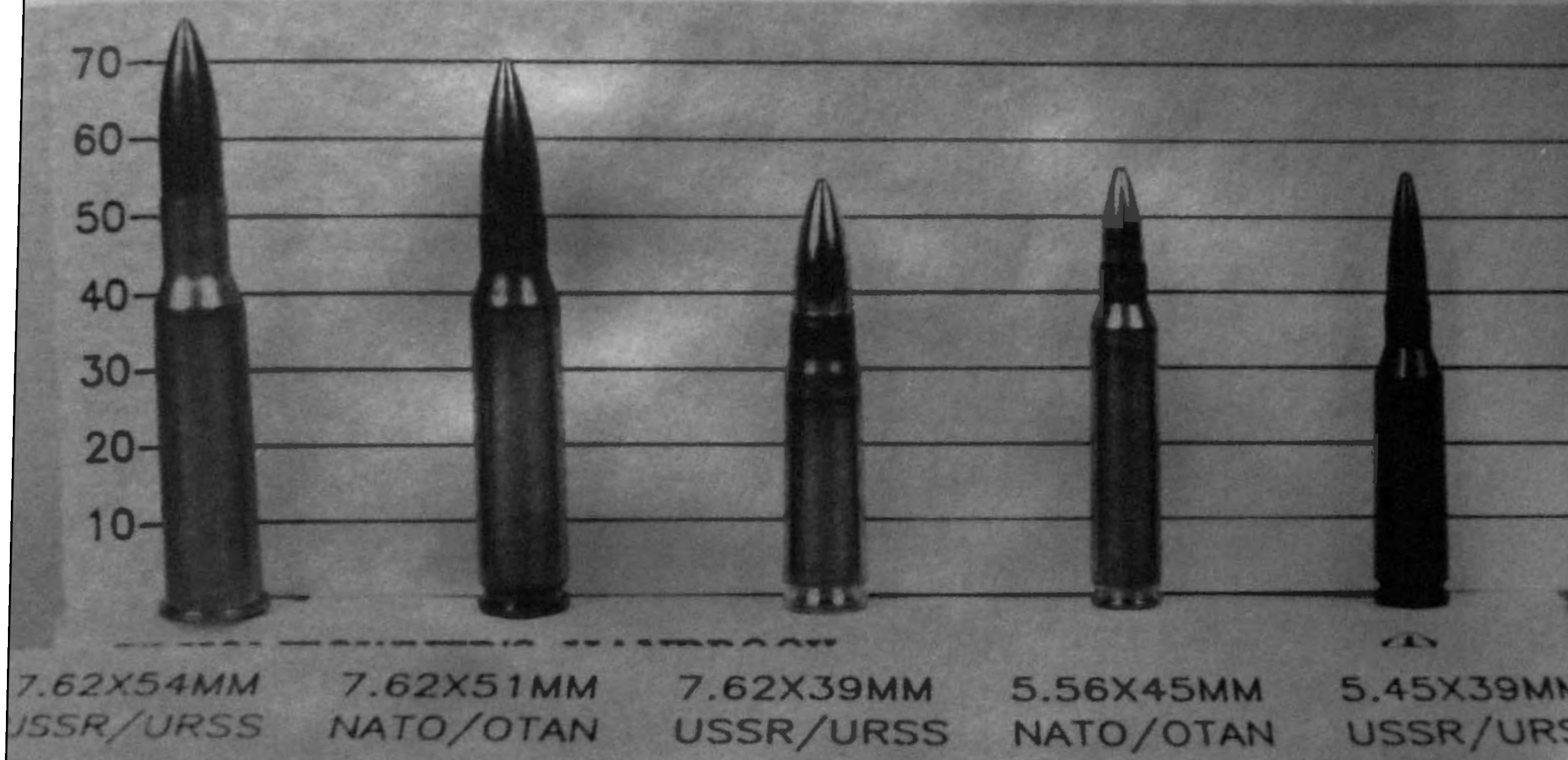
398. A Colt-made M16A1, purchased for Canadian trials before the C7 program began, shown fitted with the "Optical Sight, Small Arms (ELCAN)", a low-mounted, day-night telescope from Ernst Leitz (Canada) Ltd., of Midland, Ontario. Note rifle test-serial no. "203".

399. Closeup of the Leitz ELCAN 3.5-power day-night telescope. As with the British SUIT and SUSAT, all the adjustments to the ELCAN sight are in the mount, which quick-attaches to the machined "universal" interface on the receiver. The design of the ELCAN shown here is described as a direct evolution of the "Unisight", proposed in 1956 for use with the C1 rifle (North American FALs, p. 151). The Elcan weighs 430 grams, is permanently sealed with dry nitrogen, has a 7° field of view, and is range-adjustable from 0-1000 meters. It has no moving parts and features a built-in tritium light source, which illuminates the tip of its vertical post reticle.

Courtesy Ernst Leitz (Canada) Ltd.

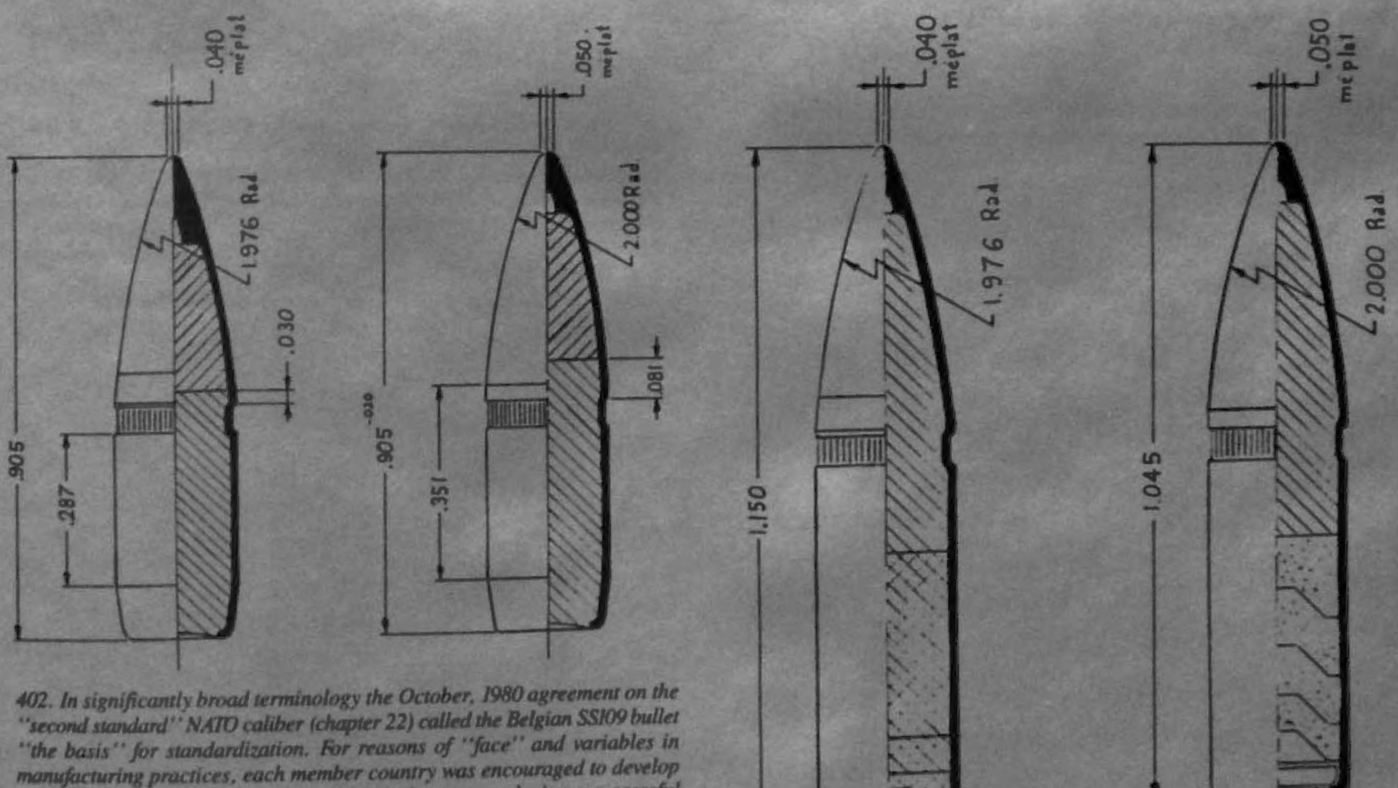


400. Right side view of a Canadian-trials FN Minimi, fitted with the ELCAN scope sight on a specially modified base, fitted to the top cover.



401. Actual-size comparison of military rifle and machine gun cartridges. From left: 1. the Russian model 1891 7.62x54mm rimmed (still the East bloc MMG and sniper rifle cartridge); 2. 7.62x51mm NATO; 3. Russian 7.62x39mm M43 (AKM and RPK cartridge); 4. Russian 5.45x39mm (AK74 cartridge).

Courtesy Small Arms Replacement Program (SARP) Ottawa



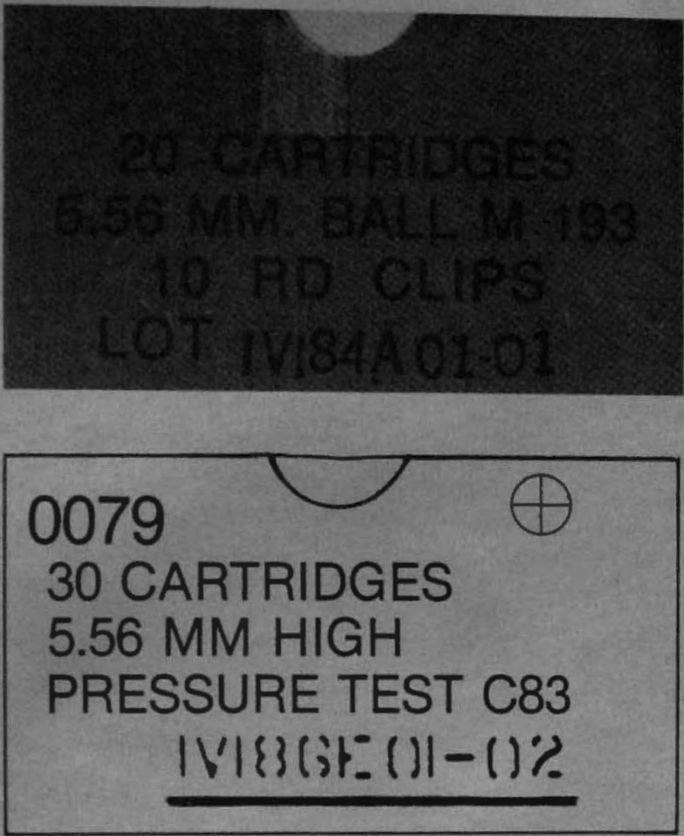
402. In significantly broad terminology the October, 1980 agreement on the "second standard" NATO caliber (chapter 22) called the Belgian SS109 bullet "the basis" for standardization. For reasons of "face" and variables in manufacturing practices, each member country was encouraged to develop its own version of the basic design. (As noted, mass-producing a successful approximation of the SS109 bullet outside of Belgium has proven exceedingly tricky, and both Canada and the US have purchased vast numbers of FN-made SS109 bullets to support ongoing 5.56mm rifle and light machine gun familiarization programs).

Above, left: 61.7-grain SS109 FN ball.

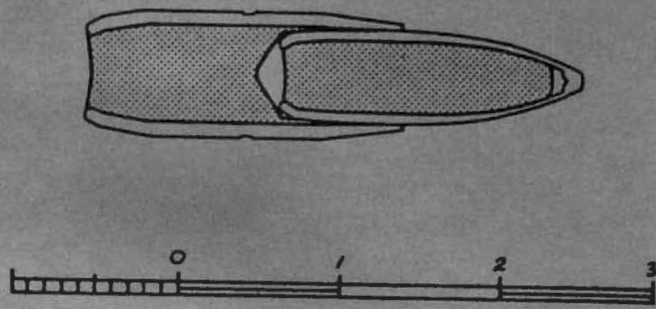
Above, right: 63.5-grain XC77 "ball model 1", an early Canadian attempt to equal the NATO performance parameters.

Below, left: 63.8-grain L110 (FN tracer).

Below, right: 64.0-grain Canadian XC78 tracer.



403. Box labels for Canadian 5.56mm ammunition, manufactured by Les Industries Valcartier Inc. (IVI), of Courcelette, Quebec.
Above: M193 ball, produced by IVI for trial and use in regular M16A1s during Canada's "switchover" from 7.62mm to 5.56mm.
Below: C83 high-pressure proof (fig. 359 no. 12).



404. An IVI 7.62 NATO cartridge box labelled enigmatically "Test lot 6 -Duplex" contained several cartridges bulleted as shown, with a 5.56-type lead-covered ball bullet snugly inserted into a hollow-nosed 7.62. (Scale in mm).
Courtesy Capt. William Etter

405. The Canadian Forces' Section Cleaning Kit, issued at Section level in support of C7 rifles and C9 light machine guns.
Contents, left side: swabs (2 packets of 100); utility brush; pipe cleaners; 4-section cleaning rod; carrier key/gas tube brush; C9 sight adjustment key; chamber brush; cleaning rod handle.
Right side: bore brushes; C9 front sight "T-tool"; C7 front sight adjustment tool; plastic bottle of CLP.
Courtesy Small Arms Replacement Program (SARP) Ottawa

END OF PART III

Appendix

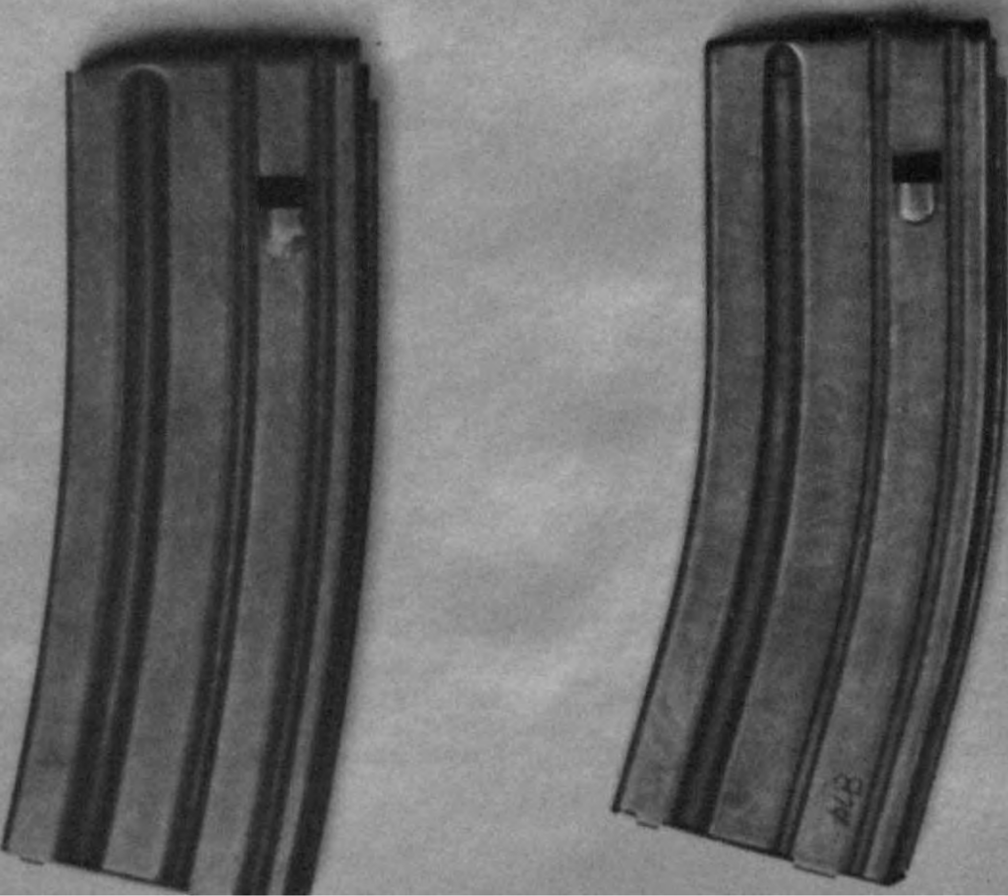
ACCESSORIES AND ANCILLARIES

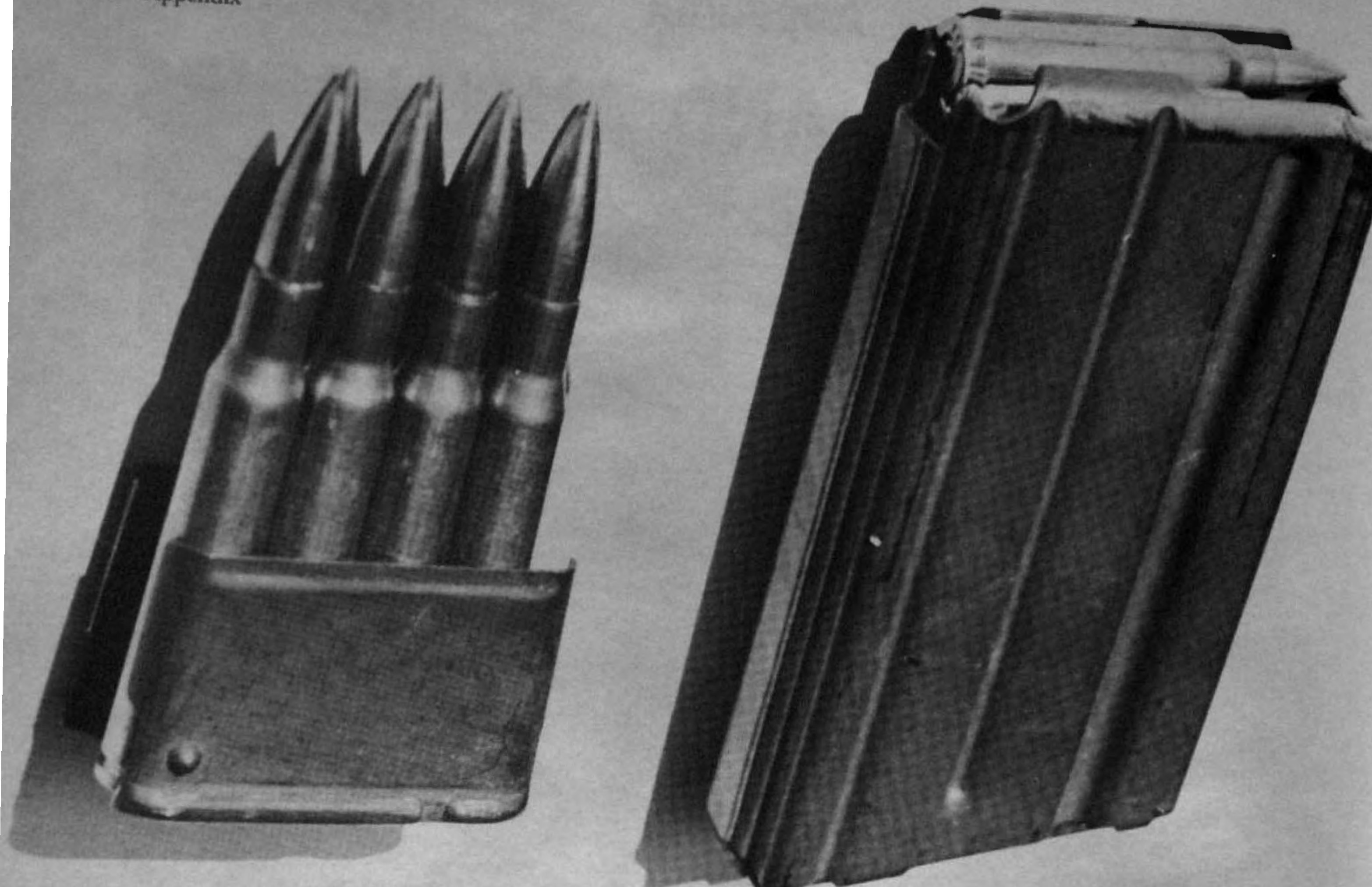
Magazines

Literally hundreds of magazine feed systems have been developed over the course of the M16 program. The most typical, as well as a few of the myriad military "one-offs" and failed Colt experiments, are shown here.

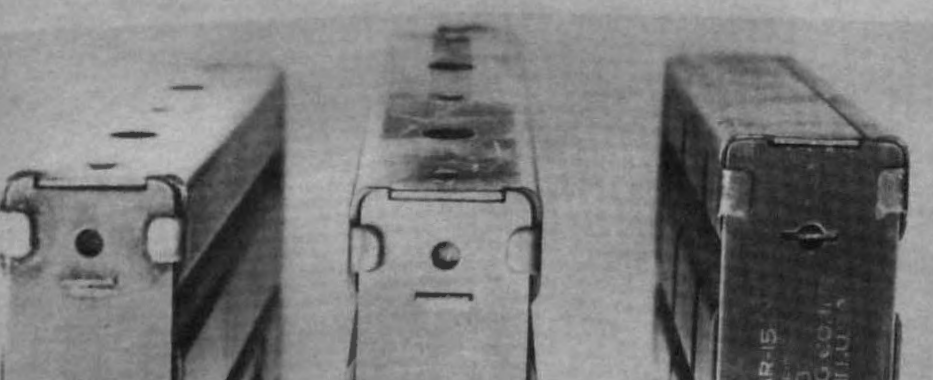
406. Above, from left: 1. original ArmaLite 25-round; 2. early Colt steel "waffle" 20-round; 3. Colt aluminum 20-round.

Below: 4. early, fully-curved Colt 30-round; 5. standard Colt 30-rounder with "straight end and intermediate arctuate portions" (fig. 418).
Bob Faris collection

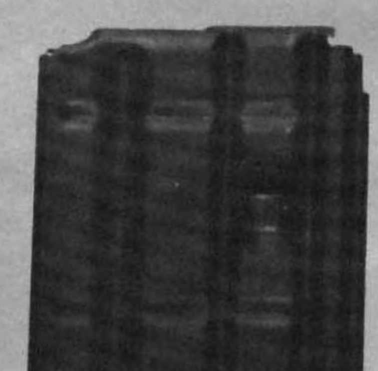




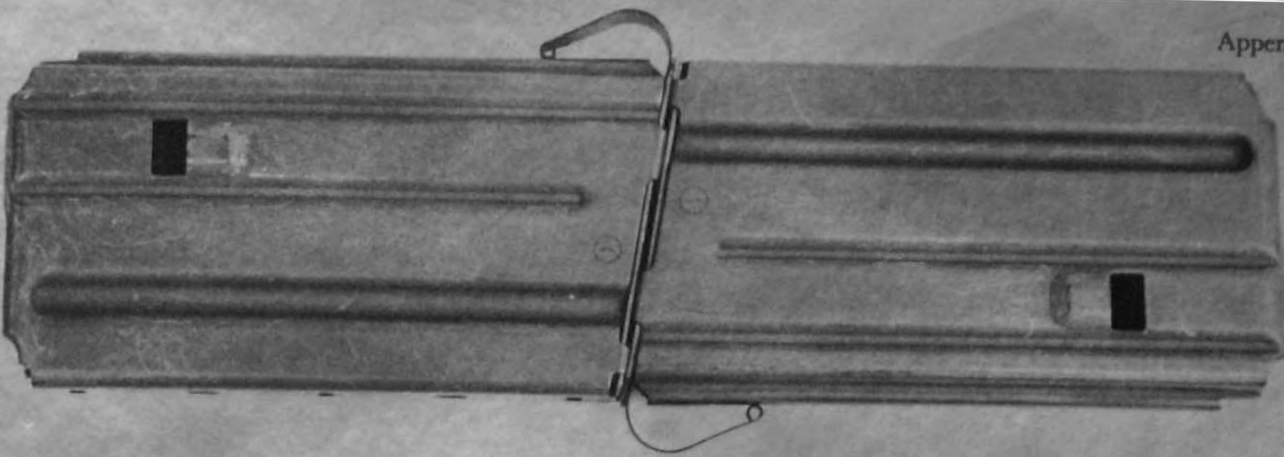
407. The comparative size of 8 rounds of .30M2 in an M1 Garand clip, and 20 rounds of M193 ammunition in magazine type 3.



408. Three styles of markings on 20-round magazine bases of Colt manufacture. Left and center: magazines type 3 (fig. 406). Right: magazine type 2.



409. Steel 20-round magazine (type 2) with "piggyback" adapter/floorplate installed, the ball of which locks together with another similarly equipped magazine to provide a quick-change, 40-round package (fig. 410).
Photo courtesy Steve Kemp

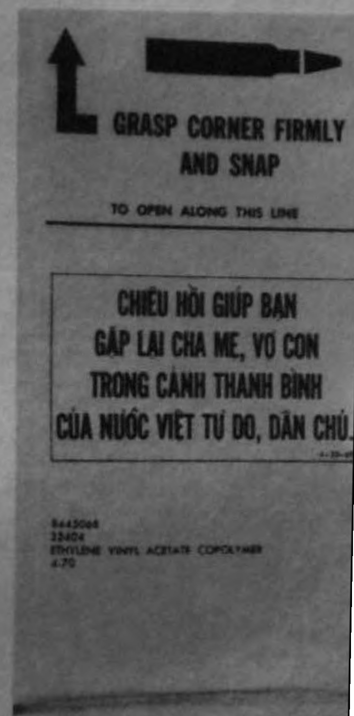


410. *Two 20-round magazines attached in a "piggyback" 40-round package.* Bob Miller collection

411. *Magazine for instructional cutaway rifle, showing positioning and feeding of cartridges.* Photo courtesy Steve Kemp

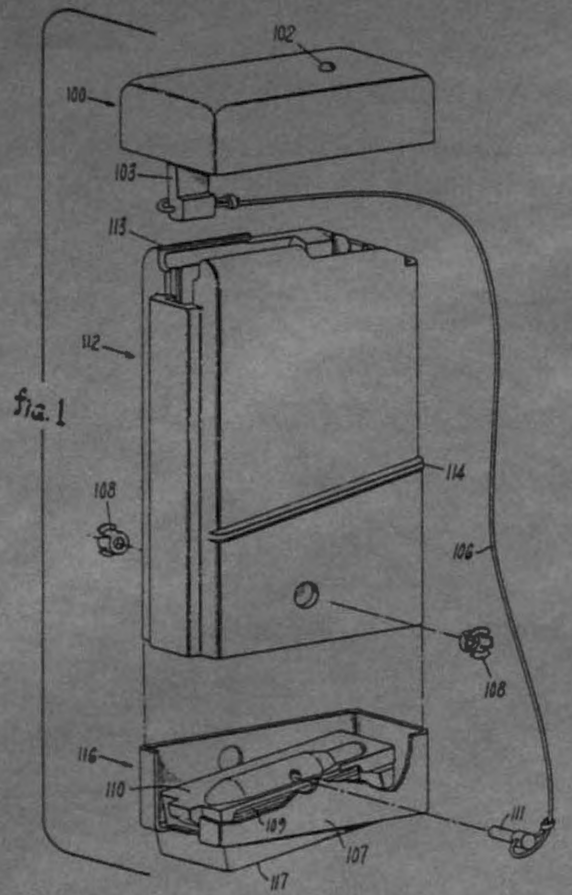
412. *20-round magazine for M200 blank ammunition. A fillet in the front reduces the internal length, thus accommodating the shorter blank rounds but not live cartridges.* Bob Miller collection

413. *Experimental plastic 20-round magazine, with molded-in steel feed lips and magazine catch. Not adopted.* Photo courtesy Steve Kemp

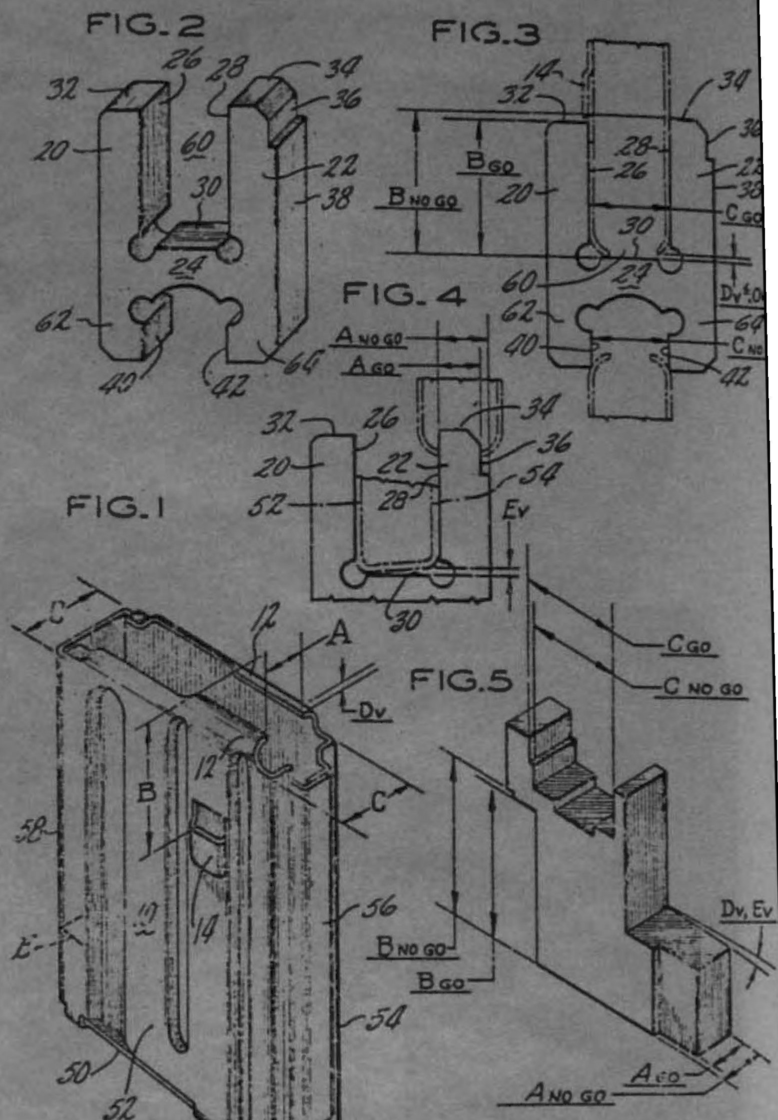


414. *A vinyl plastic pouch, issued to US soldiers in Vietnam. A loaded 20-round M16A1 magazine was inserted from below and the metal tab end (bottom) was folded and crimped, thus keeping the magazine and its cartridges dry and clean. Once used and discarded, it was hoped that the safe-conduct message (center, printed in Vietnamese) would be spotted and used by defecting enemy troops.* Bob Miller collection

415. *One of several disposable plastic magazines developed for the M16 (see fig. 416).* Photo courtesy Steve Kemp

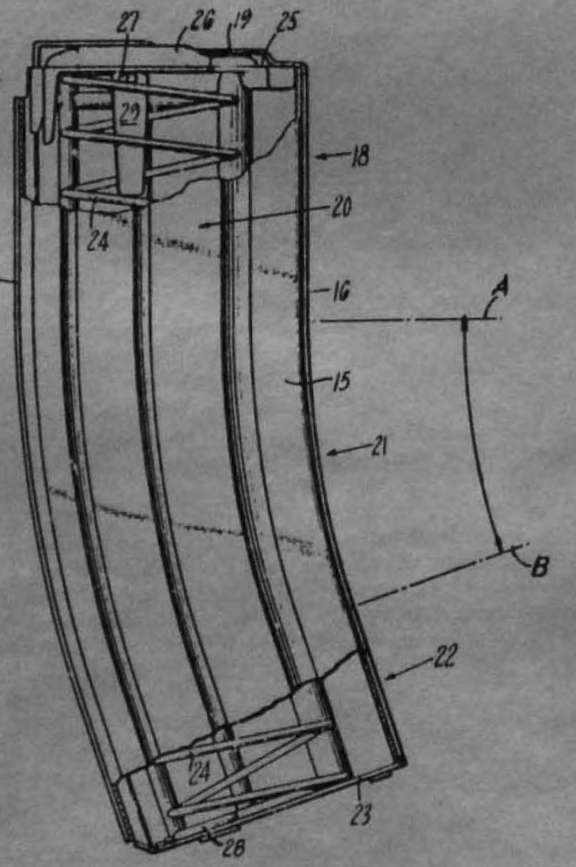


416. Fig. 1 from US Patent no. 3,453,762 granted to Colt engineer Robert D. Fremont (co-designer of the 5.56mm Stoner 63), entitled "Disposable Magazine Having a Protective Cover and Follower Retaining Means". Colt's refusal to provide dimensions for the Army's disposable magazine (chapter 17) spurred this "in-house" development. Not adopted. US Patent Office



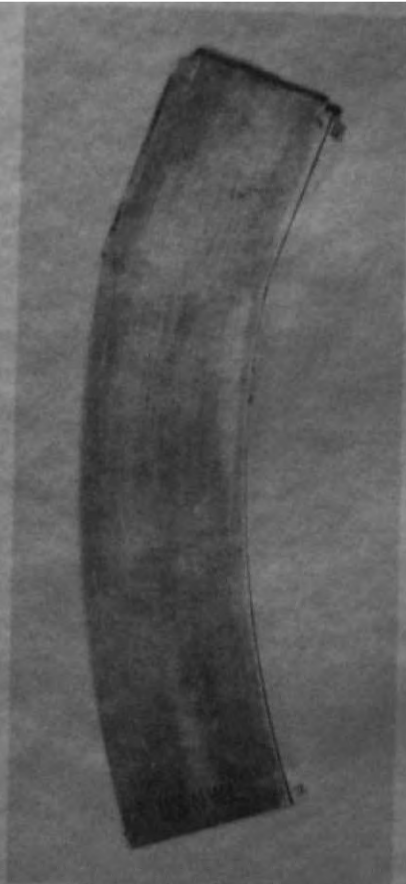
417. Figs. 1 through 5 from US Patent 3,482,322 granted to Colt's Kanemitsu (Koni) Ito, entitled "Method of Preventing Malfunction of a Magazine Type Firearm and Gage for Conducting Same". Hailed at first as a method of weeding out dented or defective 20-round magazines, this ingenious block was designed to check every critical dimension. Enthusiasm waned when it was discovered that some magazines which failed inspection worked well, while others which passed would jam. US Patent Office

FIG. 1



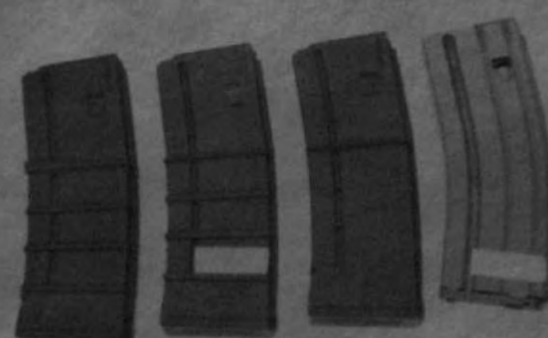
418. Fig. 1 from US Patent 3,440,751 granted to Colt's Robert D. Fremont, entitled "Firearm Box Magazine with Straight End and Intermediate Arctuate Portions". While not as desirable as a fully-curved magazine (fig. 406 type 4), the Fremont design proved the only workable way to provide a 30-round magazine capacity for the variously-dimensioned magazine wells of all the AR-15/M16/M16A1 rifles in military service (chapter 15). US Patent Office

419. Colt's "proprietary" 30-round magazine, introduced in 1969 after a 3-year development program (chapter 15).
Rock Island Arsenal photo dated December 2, 1969



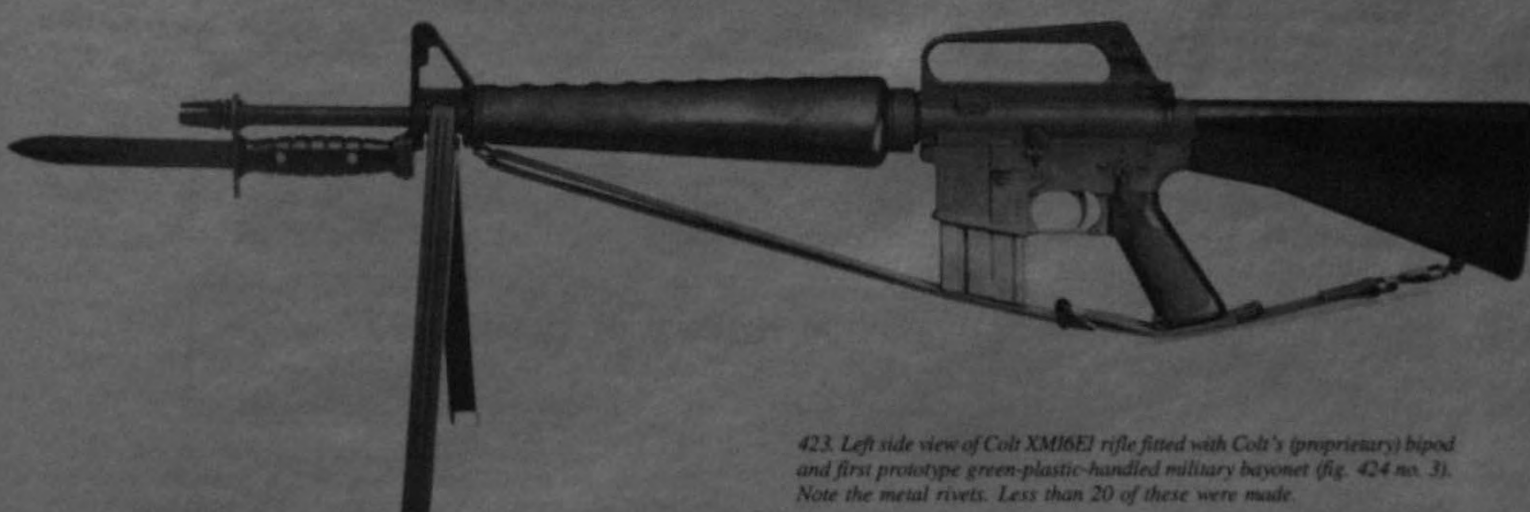
420. A prototype of an experimental 50-round magazine developed for the M16 rifle by the Naval Weapons Laboratory at Dahlgren, Virginia.
Bob Miller collection

421. An early GAPCO nylon 30-round magazine. Numerous styles and models of all-plastic magazines have been developed for the M16, the most successful being the Canadian pattern (figs. 392 and 422).



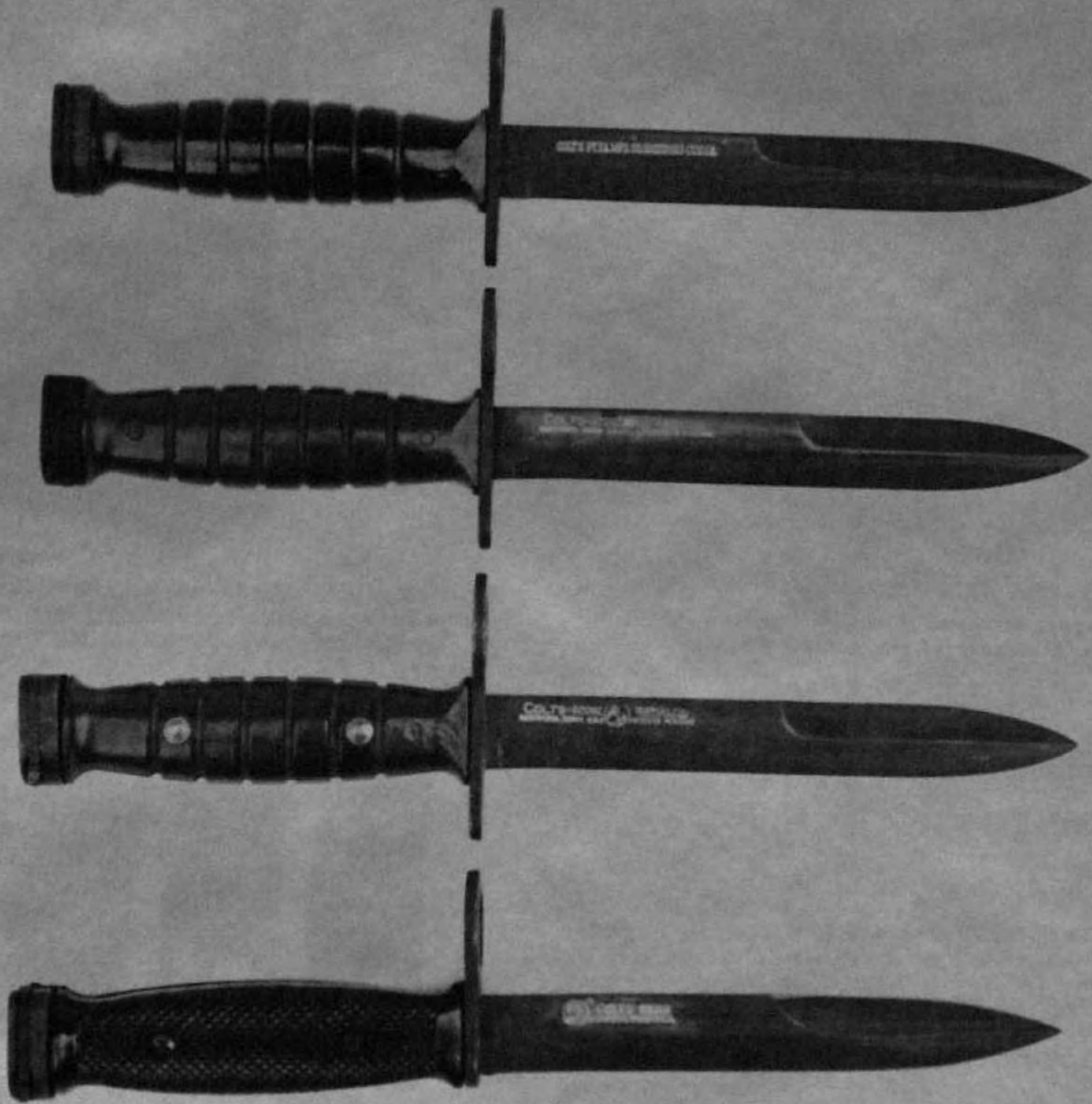
422. Three iterations of nylon magazine made to Canadian pattern and leading to the adoption of "470,570 units" of a finalized and improved version of no. 1 (left) by the Canadian Forces for the C7/C8/C9 weapons system.

Bayonets



423. Left side view of Colt XM16E1 rifle fitted with Colt's (proprietary) bipod and first prototype green-plastic-handled military bayonet (fig. 424 no. 3). Note the metal rivets. Less than 20 of these were made.

Early Colt Bayonets



424. A compendium of four early Colt-marked bayonets for the AR-15/M16. From top: 1. one-line-address brown-handle prototype.
2: Colt/ArmaLite-marked green-handled prototype, Colt part no. 62082.
3: original green-handled prototype with rivetted 2-pc. handle. Less than 20 of these were made, in the Colt model shop, with blades obtained from a small commercial contractor in West Haven, Connecticut.
4. the forerunner of the military M7. Same Colt logo as no. 2, above, but faintly marked around front of muzzle ring "Made in W. Germany". Made (with and without lower crossguard) by Eickhorn of Solingen for Colt's in support of the Singapore order (chapter 12).
Bob Miller collection, photo by Roy Arnold

Initially considered proprietary by Colt's, the AR-15/M16 bayonet was the only such item ever produced by the firm. It was also the first item of issue "broken out" by the Army. Colt's continued to contract out for "proprietary" bayonets of their design (fig. 424 no. 4) to support overseas orders.

Development and History of the US M7

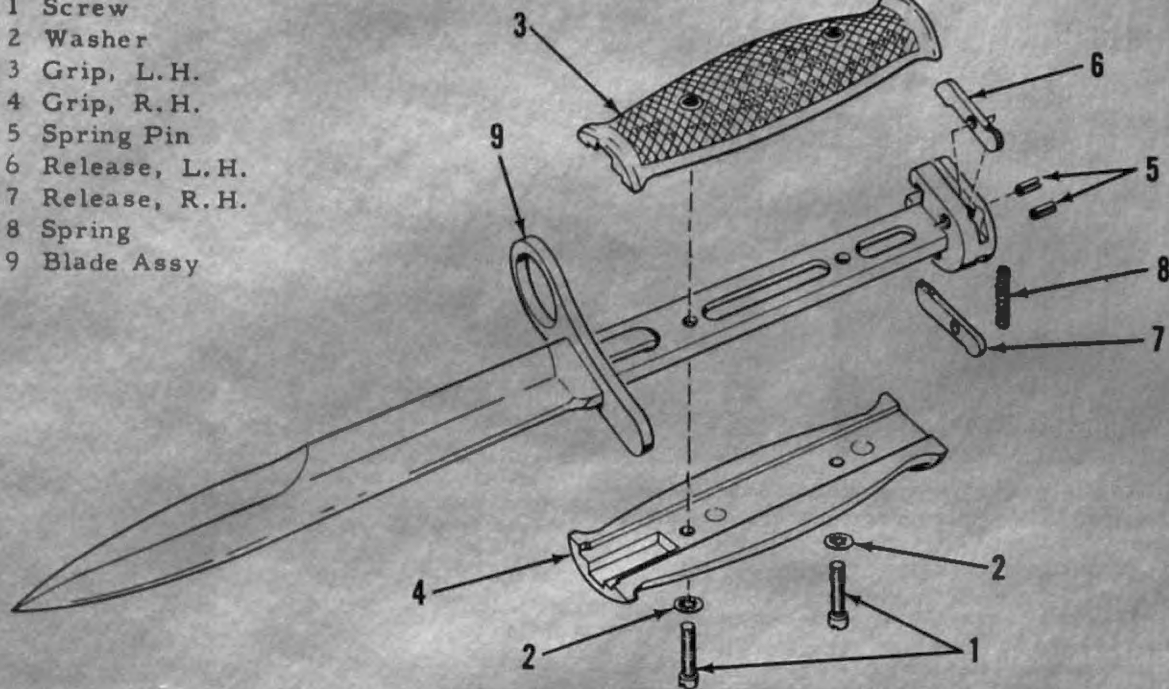
A short program of military engineering development at Springfield Armory led to US adoption of the "Knife, Bayonet, M7":

Project: rifles [week of] 24-28 February, 1964

Knife, Bayonet, M7: *A contract was awarded to Columbus Milpar and Mfg. Co., Columbus, Ohio, for Bayonet Knives on 25 February 1964, with initial delivery scheduled on or before 9 June 1964.*

The majority of M7 bayonets used in Vietnam were produced under a government contract with Bauer Industries of Ohio, makers of tank armor and gun turrets. The Imperial Shrade Corp. of Providence, Rhode Island has been the prime contractor of M7 bayonets since 1970.

1 Screw
2 Washer
3 Grip, L.H.
4 Grip, R.H.
5 Spring Pin
6 Release, L.H.
7 Release, R.H.
8 Spring
9 Blade Assy

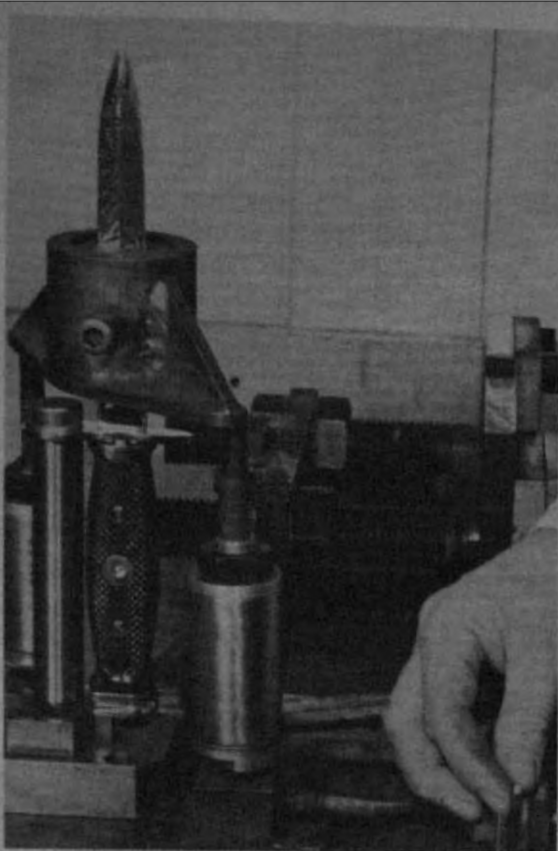


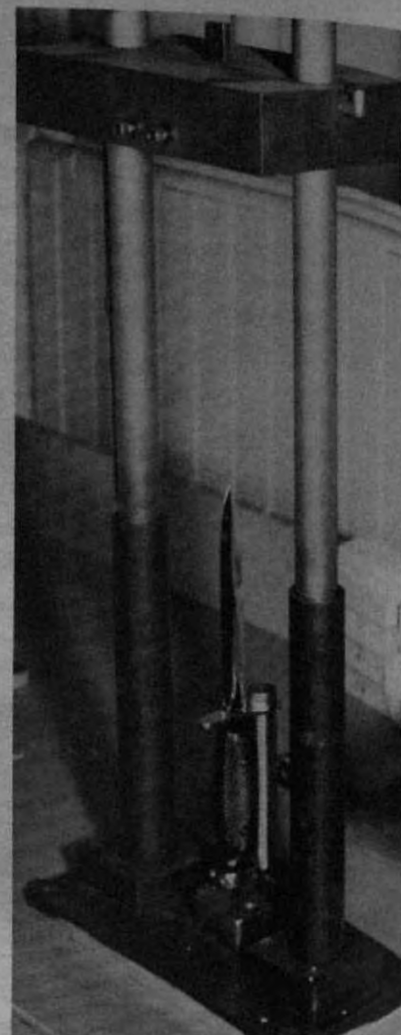
425. The US "Bayonet Knife M7", showing names of components. Internally, the Eickhorn bayonet (fig. 424 no. 4) is similar but not exactly the same.

The American Historical Foundation's Vietnam War Commemorative Bayonet

426. Four versions of a recent, tenth-anniversary Vietnam War commemorative bayonet, designed by B. J. Weber and manufactured by Imperial Schrade for the American Historical Foundation of Richmond, Virginia. Limited editions of 2,500 of each pattern feature varied motifs of "snakes, dragons, bamboo and flames".

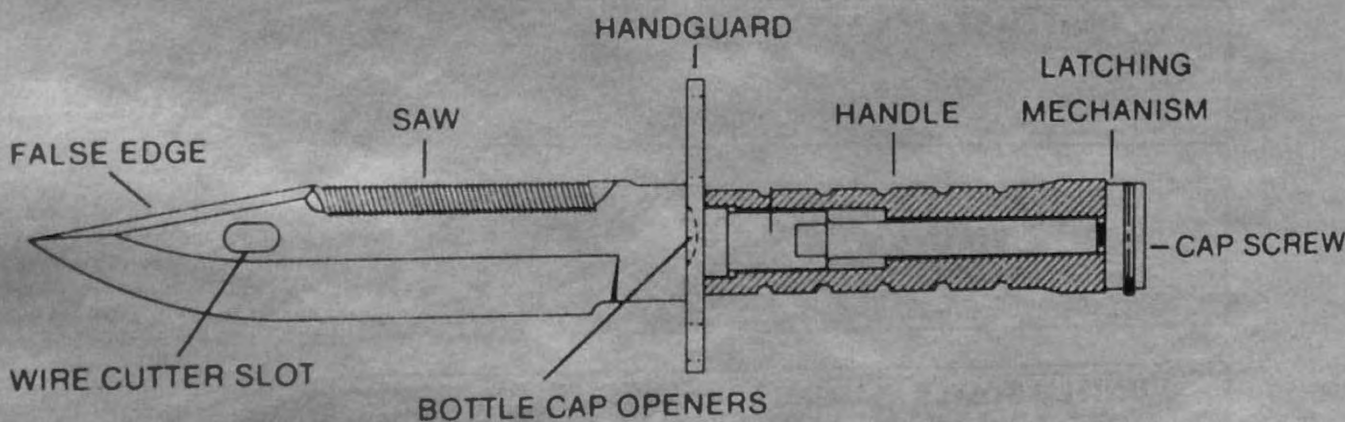
Courtesy American Historical Foundation

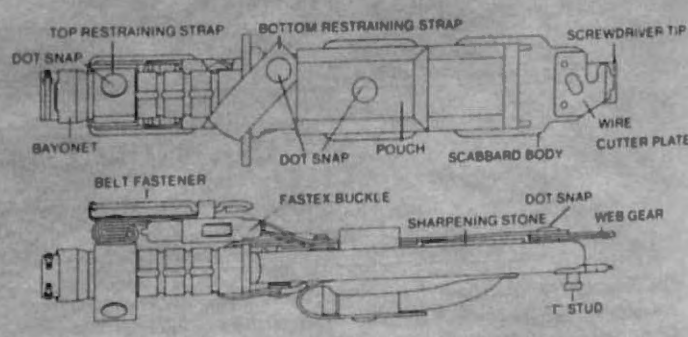




427. The Vietnam commemorative bayonets are subjected to the same set of tests each M7 must pass before being accepted by the military. Three of these are shown here:
Left: hydraulic cylinders apply upward pressure to prove bayonet's secure attachment to (slave) bayonet stud.
Center: with first 1 1/2" of blade gripped in vice, handle must return to center after being deflected over a 2 1/2" arc.
Right: steel plate containing maple block is dropped onto blade tip with 28 ft-lbs. of energy. Bayonet must withstand force "without fracture, permanent deformation or loosening of parts". *Courtesy American Historical Foundation*

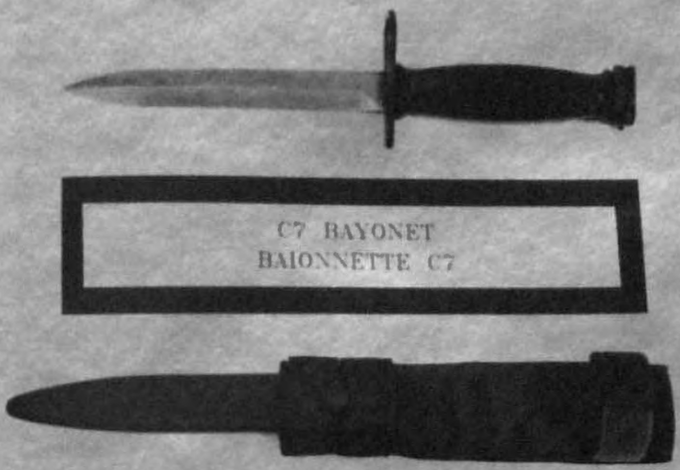
The New US M9 from Phrobis III





428. Three views of the new "Multi Purpose Bayonet System M9" (MPBS) designed by Phrobis III Ltd., of Oceanside, California. An initial $15.6M contract for the manufacture of 315,600 M9s (under license by Buck Knives of El Cajon, California) was awarded by the Army Armament, Munitions and Chemical Command (ARMCOM) in October, 1986. The M9 MPBS weighs 1.76 lbs. (with Zytel scabbard and rear-mounted whetstone) and features a 7" blade made of glass-bead-blasted 425 stainless steel, a black-oxided crossguard, and a grooved-and-knurled handle also made of high-impact Zytel.
Courtesy MGySgt James W. Maddock

The Stainless-Steel Canadian C7 Bayonet

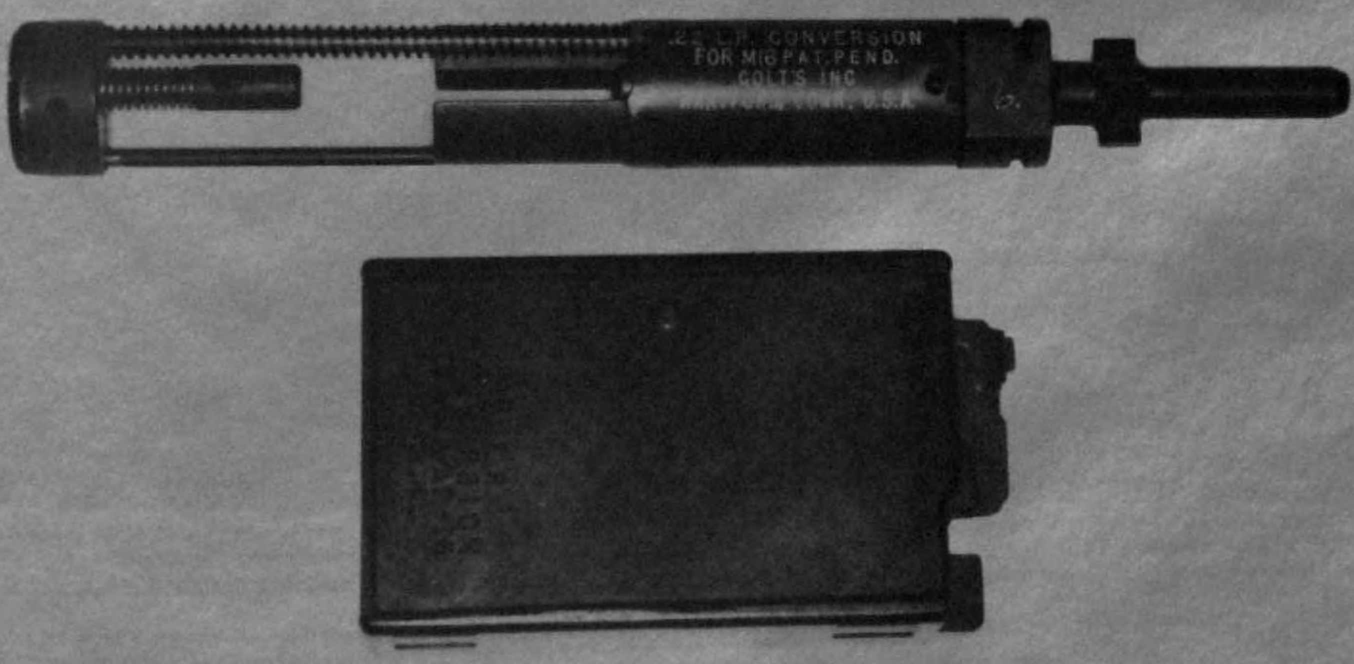


429. The C7 bayonet, 70,000 of which are being manufactured for the Canadian Forces under a $1.7M contract by Nella Cutlery Service of Stoney Creek, Ontario. The C7 is built to the German Eickhorn pattern (under a technology-transfer agreement with Imperial Schrade) and features a sandblasted stainless steel blade and a velcro-fastened plastic scabbard.
Courtesy Small Arms Replacement Program (SARP) Ottawa

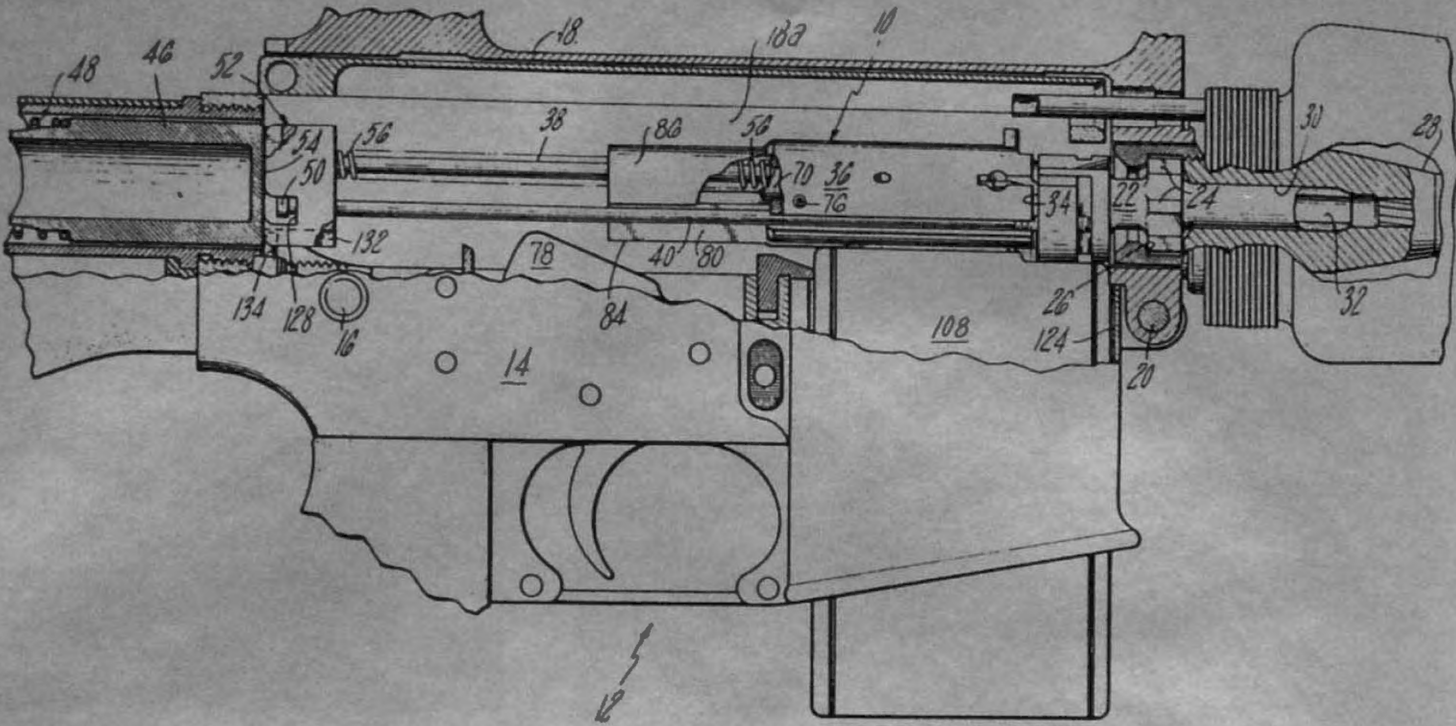
430. Closeup of the markings on the Canadian C7 bayonet.
Photo courtesy Robert J. Dynes

Conversion Units and Adaptations

Colt's .22 Rimfire Adapter



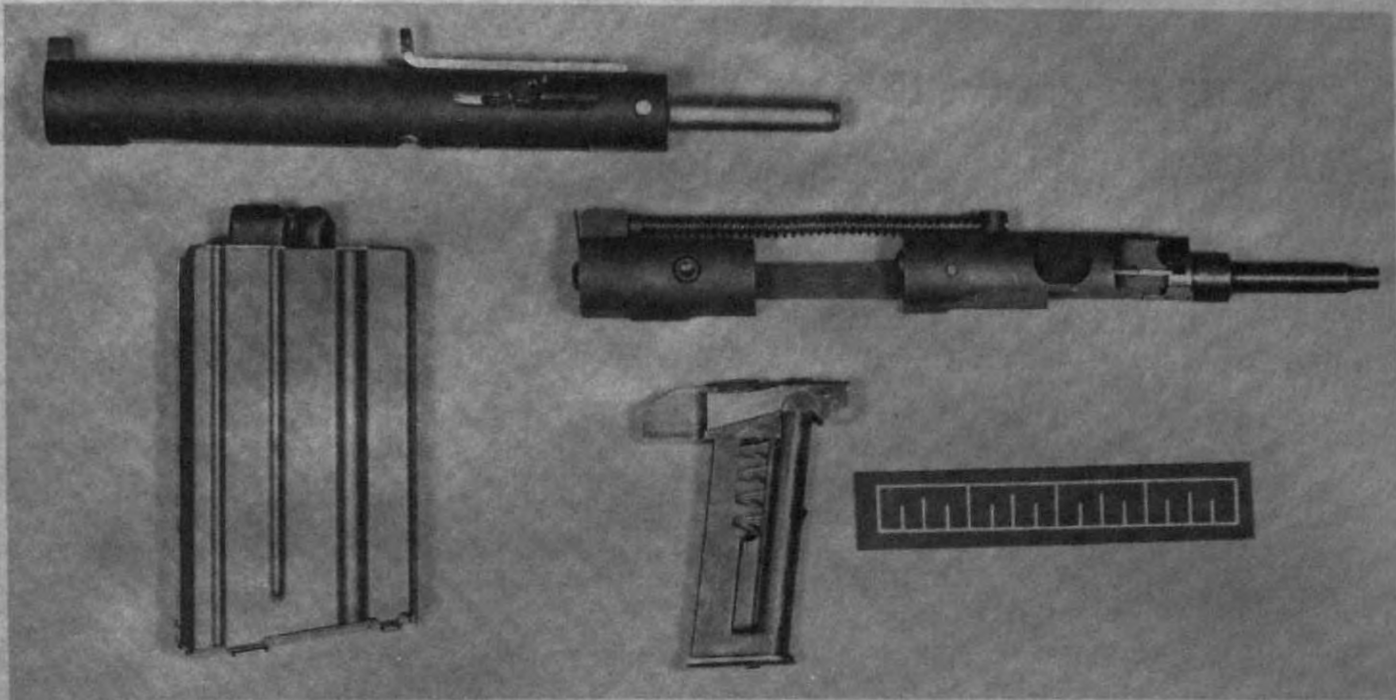
431. Colt's blowback .22LR conversion kit for the AR-15/M16.
Bob Miller collection



432. Fig. 1 from US Patent 3,771,415, granted to Henry A. Into and Richard L. Costello and assigned to Colt's, entitled "Rifle Conversion Assembly".
US Patent Office

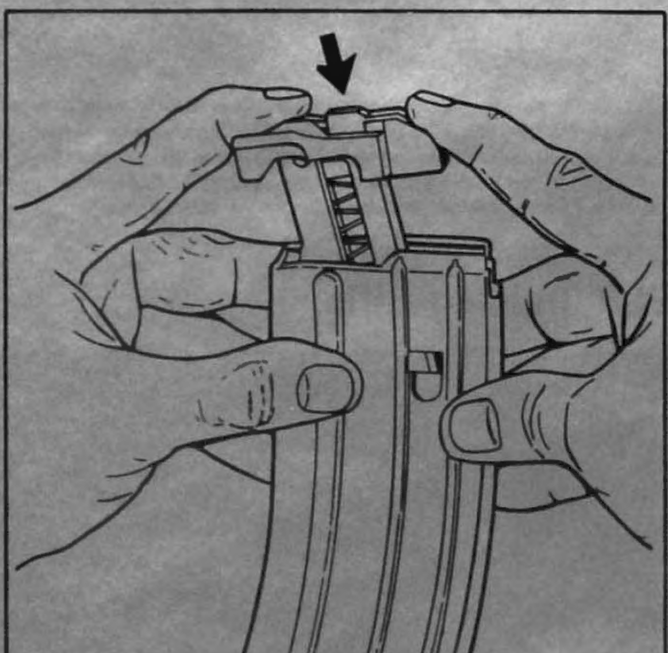
Military Conversion Unit Trials - the M261

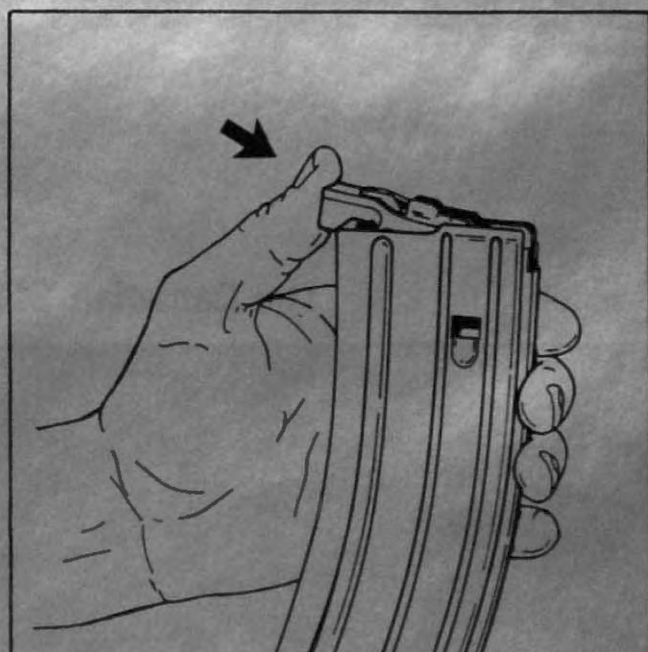
433. From a military trial of conversion units:
Left: Colt's .22LR conversion (fig. 431).
Right: Military Armament Corp. conversion unit, designed by Max Atchisson.
Center: prototype USAF conversion kit, designed by MSgt. Julius Jurek at Langley AFB, Virginia and labelled simply "prototype".
Rock Island Arsenal photo dated October 11, 1973



434. The choice for adoption as a US military training aid narrows down. Left: Atchisson conversion unit from Military Armament Corp. (MAC). Right: prototype of the conversion unit designed by John Foote for US Armament Corp. which became the M261. Note the machined magazine adapter.

Rock Island Arsenal photo dated February 14, 1975





435. The finalized version of the Foote conversion unit (fig. 434) became the M261 rimfire adapter kit. Saco Defense Systems Division of Maremont Corporation of Saco, Maine produced over 63,000 M261 kits under a $4.9M contract. The M261's 10-shot magazine adapter is installed without modification or tools into the regular 30-round M16A1 magazine. Left: positioning adapter and depressing into magazine. Right: hooking adapter under magazine lips and sliding into position.

The US M2 Practice Bolt and M882 Plastic Training Ammunition

ARMY TM 9-6920-746-12&P
MARINE CORPS TM 6920-12&P

PERATOR'S AND ORGANIZATIONAL MAINTENANCE MANUAL
(INCLUDING REPAIR PARTS AND SPECIAL TOOL LIST)

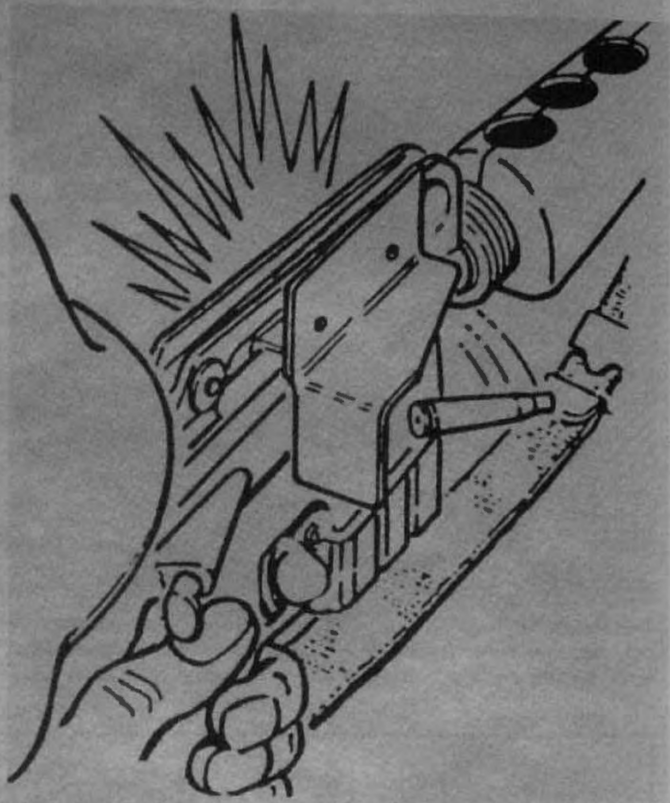
M2 PRACTICE BOLT

FOR PLASTIC AMMUNITION
NSN 1005-01-184-4041
for RIFLE 5.56MM, M16 SERIES

HEADQUARTERS, DEPARTMENT OF THE ARMY
HEADQUARTERS, MARINE CORPS

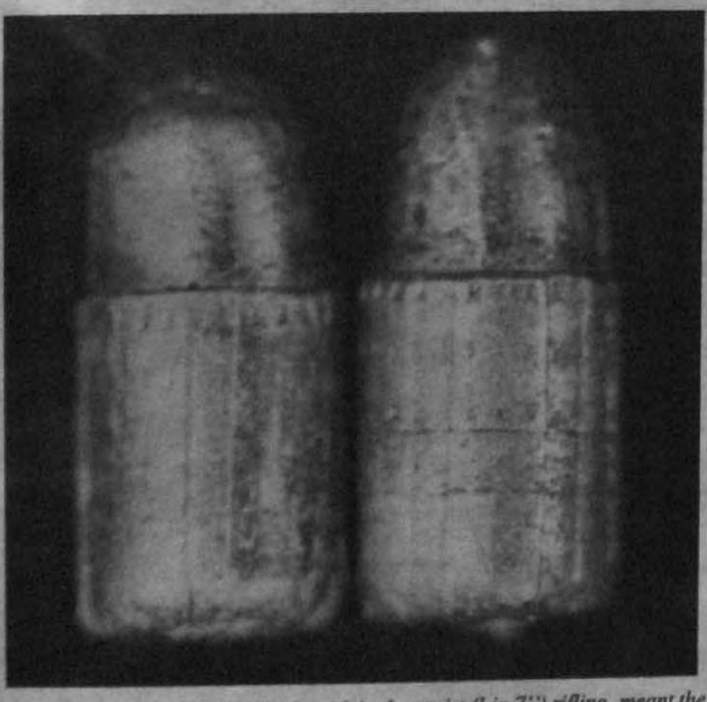
SEPTEMBER 1986

436. In a later approach to short-range training, the Army and Marine Corps adopted the blowback "M2 Practice Bolt", designed to fire M862 Plastic Training Ammunition (maximum range: 250 meters). Note the absence of the bolt carrier key.

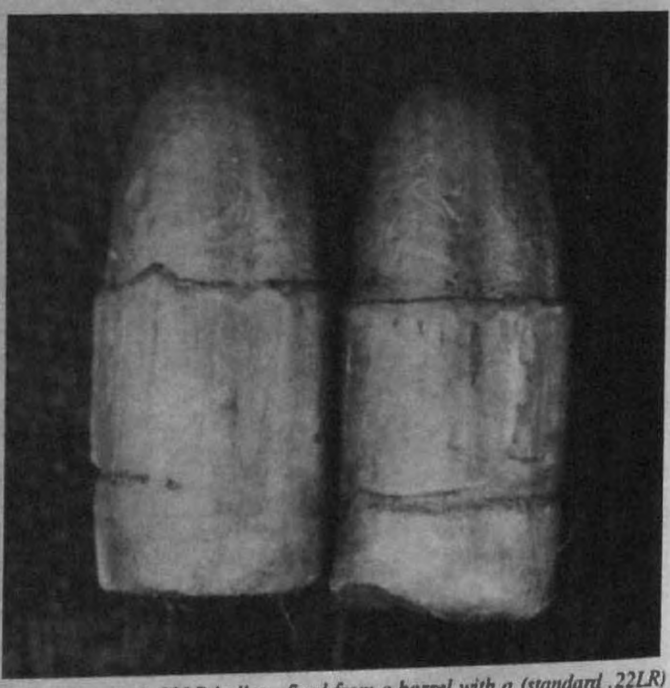


437. Due to the straight-blowback method of operation of the M2 Practice Bolt, the limited-range, blue-plastic-bulleted M862 training ammunition produced considerable breech flash when fired. To prevent shooters from being hit in the face by ejected cases or burning propellant, rifles used in training were equipped with a bolt-on cartridge deflector, as shown here.

The Canadian C10 .22LR Training Rifle



438. The adoption of the M16A2, with its fast-twist (1-in-7") rifling, meant the end of any training adaptations using .22LR conversion kits. Canadian experiments proved that soft-lead .22LR bullets were severely deformed (and produced excessive lead fouling) when fired from fast-twist barrels such as the 1-in-7 C7 rifle.



Left: recovered .22LR bullets, fired from a barrel with a (standard .22LR) 1-in-16" rifling twist.
Right: recovered .22LR bullets, fired from a 1-in-7"-twist C7 rifle barrel.
Courtesy Diemaco, Incorporated

439. Left side closeup view of the proposed semi-auto-only C10 training rifle, developed under Canadian Armed Forces contract by Diemaco, Inc. of Kitchener, Ontario. Weight: 7.6 lbs. Caliber .22LR, magazine capacity 15 rounds. 20.4" barrel with 6-groove rifling, right-hand twist, 1 turn in 16". Straight blowback operation. Sights have been modified for optimum accuracy at 30 and 100-meter ranges (front C7 post reduced to 0.052" width, rear C7 aperture reduced to 0.050" diameter). The (dedicated) C10 shares 83% parts commonality with the selective-fire C7, incorporating 14 new and 7 modified parts.

Courtesy Diemaco, Incorporated

440. Markings on the proposed C10 .22LR training rifle from Diemaco, Inc.: 22LR TW 1/16.

EPILOGUE

The M16's Finest Hour

This retrospective is necessarily limited by its publication date, but, as time will no doubt continue to prove, the M16's finest hour is NOW. This situation shows every sign of lasting until the end of the century, despite government-sponsored Advanced Combat Rifle (and even newer) caseless cartridge and flechette programs wherein prototype development has reached an impressively advanced state.

As proof of the ongoing nature of the M16 program, we present some illustrations received literally at the moment of going to press from Colt's Military Sales Division.

The XM4 Carbine

441. Left and right side views of a special Colt M16A2 Carbine made for AbuDhabi (Colt model 727), shown fitted (via a modified mount) with an M203 grenade launcher. The model 727 features a 14.5" heavy barrel and both AUTO and BURST capability. Colt's is quite enthusiastic about the model 727 because, unlike the XM177E2, the user gives up very little indeed in terms of accuracy and velocity to gain the versatility of this impressive "package". The 727 is a decided improvement over the light barreled model 723, and Colt's is moving towards standardizing the new version.

At the time of writing, Colt's has produced between 30 and 40 examples of a new US military trials version of the Abu Dhabi Carbine, officially called the XM4.

BIBLIOGRAPHY

Books

EM-2 Concept and Design - A Rifle Ahead of its Time by Thomas B. Dugelby. Collector Grade Publications, Toronto, Ont., 1980.

German 7.9mm Military Ammunition, 1888 - 1945 by Daniel W. Kent. Private printing, Ann Arbor, Mi., 1973.

Le M16 by Jean Huon. Editions Crepin-Leblond, Paris, France, 1983.

Modern Military Bullpup Rifles by T. B. Dugelby. Collector Grade Publications, Toronto, Ont., 1984.

North American FALs - NATO's Search for a Standard Rifle by R. Blake Stevens. Collector Grade Publications, Toronto, Ont., 1979.

Small Arms Today by Edward Clinton Ezell. Stackpole Books, Harrisburg, Pa., 1984.

The Great Rifle Controversy by Edward Clinton Ezell. Stackpole Books, Harrisburg, Pa., 1984.

The Metric FAL - The Free World's Right Arm by R. Blake Stevens and Jean E. Van Rutten. Collector Grade Publications, Toronto, Ont., 1981.

The SPIW - The Deadliest Weapon that Never Was by R. Blake Stevens and Edward C. Ezell. Collector Grade Publications, Toronto, Ont., 1985.

UK and Commonwealth FALs - Volume Two of the FAL Series by R. Blake Stevens. Collector Grade Publications, Toronto, Ont., 1980. Revised and reprinted, 1987.

US Rifle M14 - From John Garand to the M21 by R. Blake Stevens. Collector Grade Publications, Toronto, Ont., 1983.

Reports and Monographs

Ezell, Edward C.: *The Death of the Arsenal System?.* Paper on the Decision to Close Springfield Armory, presented to the Organization of American Historians, April 18, 1968.

Michault, Jacques S.: *Development of the M16 Rifle.* 3-pg. monograph.

Nonte, George C.: *Philco-Ford's 40mm Grenade Launcher.* 2-pg. draft article, undated.

Rayle, Lt. Col. Roy E.: *Growth of a Rifle.* Unpublished manuscript, dated July, 1961.

Stoner, Eugene M.: *AR-15/M16 Data, History and Development* 12-pg. monograph, dated April 18, 1964.

US Government Printing Office, Washington, D. C.:

Hearings Before the Special Subcommittee on the M16 Rifle Program[the Ichord Hearings], dated May through August, 1967.

Report on the M16 Rifle Program[the Ichord Report]. October, 1967.

Technical Reports - US Military Agencies

Aberdeen Proving Ground, Md.

Ballistic Research Laboratories (BRL):

A Comparison of Proposed Small Arms Weapons Systems. Memorandum Report No. 1139, dated April, 1958.

A Kinematic Evaluation of the AR-18 Rifle, Cal. 0.223 by Richard F. Cronin, dated February, 1965.

Accuracy of Rifle Fire: SPIW, M16A1, M14. Memorandum Report No. 1919, dated March, 1968.

An Effectiveness Study of the Infantry Rifle by Donald L. Hall. Memorandum Report No. 593, dated March, 1952.

Penetration of an Experimental .22 Cal. Bullet in Gelatin. Memorandum Report No. 1109, dated October, 1957.

Provisional Probabilities of Incapacitation by a Caliber 0.30 Rifle-Bullet, Ball M2. Memorandum Report No. 949, dated December, 1955.

Development and Proof Services:

A Test of Rifle, Caliber 7.62mm, AR-10 by L. F. Moore. Report No. DPS No. 101, dated November, 1960.

A Test of Rifle, Caliber .223, AR-15 by L. F. Moore. Report No. DPS-96, dated November, 1960.

A Test of SALVO Rifle Material by L. F. Moore. Fortieth Report on Ordnance Corps Project No. TS1-2, dated September, 1957.

Comparative Evaluation of AR-15 and M14 Rifles by G. E. Hendricks. December, 1962.

Comparison Test of Rifle, 5.56mm, M16 by J. A. Tolen. Report No. DPS-1471, dated October, 1964.

Design and Fabricate a High-Velocity Caliber .22 Cartridge, Modify a Standard M2 Carbine to Fire the Cartridge, and Evaluate the Weapon-Ammunition Combination by G. A. Gustafson. Twenty-fifth Report on Project TS1-2, dated September 29, 1953.

Test Analysis and Operations Office:

Improved Performance of Ammunition for the M16 Rifle by G. A. Gustafson, dated April 1, 1966.

Human Engineering Laboratory (HEL):

Dispersion Versus Cyclic Rate Test of 4.32mm Cartridge by Orest Zubal. Technical Note 8-74, dated October, 1974.

Noise Suppressor Assembly, HEL M4 for Use with Rifle, 5.56mm, M16A1. Interim Operation and Maintenance Manual.

Preliminary Operation and Maintenance Manual for the 30mm Multi-Shot Grenade Launcher (Rifle Mounted for Conceptual Testing on a Modified M16A1) by M. Mark Brauer and Richard J. Carter. Technical Note 5-78, dated June, 1978.

Summary of Studies Conducted with the AR-15 by James P. Torre, Jr. Technical Note 2-63, dated January, 1963.

Advanced Research Projects Agency (ARPA), Arlington, Va.

Test of ArmaLite Rifle, AR-15. Report of Task No. 13A, dated July 31, 1962.

Army Arctic Test Board, Fort Greely, Ak.

Evaluation of Single Flechette and 6.35-MM Simplex and Duplex Ammunition. Project No. ATB 3-270, dated May 7, 1960.

Army Armament Command, Rock Island, Il.

Laboratory Posture Report FY 1974.

System Assessment for the 5.56mm Rifle M16A1, dated January 20, 1975.

Army Armament Materiel Readiness Command, Rock Island, Il.

Firing Port Submachine Gun 5.56mm XM231 Operator's Manual (TM 9-1005-309-10) dated April, 1979.

Small Arms Weapons Systems (SAWS) Directorate, Gen. Thomas J. Rodman Laboratory:

Gun, Machine; 6.00mm, XM235 Preliminary Operators and Organizational Maintenance Manual dated July 1, 1974.

Army Concept Team in Vietnam (ACTIV)

XM203 Grenade Launcher Attachment Development. Final Report of ACTIV Project No. ACG-14/69I dated September 15, 1969.

Army Infantry Board, Fort Benning, Ga.

Evaluation of .30 Caliber Duplex Ammunition. Report of Project No. 2853, dated August 17, 1959.

Army Materiel Command Research, Development and Engineering Directorate

The M16 Rifle - A Case History A Report for the Blue Ribbon Defense Panel. By Dr. Frederick H. Carten, undated, circa 1970.

Army Weapons Command, Rock Island, Il.

Annual Historical Summary. July 1, 1962 to June 30, 1963 (Fiscal Year 1963).

M16 Rifle Negotiation - Definitization of a Letter Contract. Case Study of period April-November, 1969.

Procurement History and Analysis of M16 Rifle. AMSWE-PPE-72-01, dated August 2, 1971.

Submachine Gun, 5.56mm, XM177E2 Preliminary Operation and Maintenance Manual (POMM 9-1005-294-14/1) dated July, 1967.

Continental Army Command, Fort Monroe, Va.

Evaluation of Small Caliber High Velocity (SCHV) Rifles. Report of Project No. 2787, dated September 19, 1958.

Defense Research and Engineering Directorate, Washington, D. C.

An Appraisal of the M16 Rifle Program, dated February, 1968.

Department of the Army Technical Manuals

Submachine Gun, 5.56mm: Port, Firing, M231 Operator's Manual (TM 9-1005-309-10) dated October 26, 1982.

Submachine Gun, 5.56mm: Port, Firing, M231 Organizational and Direct Support Maintenance Manual (TM 9-1005-309-23&P) dated March, 1983.

Frankford Arsenal, Philadelphia, Pa.

Compilation of..Memo Reports on 5.56mm AR-15/M16 Rifle/Ammunition System. Various authors and reports from 1963-1970. Report No. 6027 dated April, 1972.

Historical Summaries 1956-FY 1972. Various historians.

Special Tests of 5.56mm Ammunition. Ten special tests; various authors. Dated February, 1968.

Office, Chief of Ordnance, Washington, D.C.

Technical Information Reports (TIR):

No. 4: *Development of Weapons for the Defeat of Personnel*. December, 1954.

No. 4-4-7B51(1): *Development of 40-MM Grenade Launcher, M79 (XM79)*. April, 1961.

Secretaries of the Army, Navy and Air Force

Rifle, 5.56mm, M16 and Rifle, 5.56mm, XM16E1 Operation, Maintenance, Repair and Replacement Parts (TM 9-1005-249-14/T.O. 11W3-5-5-1/NAVWEP O.P. 3333) dated June 15, 1964.

Springfield Armory, Springfield, Ma.

Chromium Plating of Caliber .22 Barrel Bores. Report No. SA-TR1-7011, dated June 10, 1957.

Feasibility Study of a Caliber .222, Salvo Type Shoulder Rifle by C. F. Packard and D. C. Fletcher. Report No. SA-TR11-3100, dated May 10, 1959.

Technical Intelligence (507th Ordnance Detachment), Detroit Arsenal, Center Line, Mi.

Preliminary Report on Rifle, Cal. 7.62mm, Model AR-10 (Netherlands). File No. 507-1-58 dated September 25, 1958.

US Air Force

Systems Command Directorate of Armament Development, Eglin Air Force Base, Fl.:
Exterior Ballistics of the AR-15 Rifle by Robert W. Cross. ASD Report No. ASD-TDR-63-2 datedJanuary, 1963.

Limited Range Test of the M16 Rifle with Eight Types of Rifle and Hand Grenades by Dewey E. Calfee, dated January, 1965.

USAF Marksmanship School:

Evaluation of AR-18 Rifle by MSgt. Louis J. Willing, Gunsmith Division. Project No. 43-70, dated June, 1970.

US General Accounting Office

Development and Cost of the Army's Special Purpose Individual Weapon System by the Comptroller General of the United States. No. B-167638, dated May 7, 1970.

USMC Naval Surface Weapons Center, Dahlgren, Va.

Improved M16A1 Rifle Instrumented Tests and Results dated August 20, 1980.

Technical Reports - Civilian Contractors

AAI Corporation, Cockeysville, Md.

Weapons & Ordnance Systems Development Programs. Confidential Report No. ER-5406, dated August, 1968.

Final Report - Design and Develop a Simplified Serial Flechette Rifle. Report No. ER-7896, dated May, 1974.

Proposal for the Development of Improved Small Arms Flechette Ammunition. Report No. ER-9481, dated June, 1978.

Armament Components, Inc., Santa Ana, Ca.

Mechanical Ammunition Supply System for Clip-Fed Weapons by V. Bobkowski. Report No. 1-57, dated January 4, 1957.

Mechanical Ammunition Supply System ("MASS") [for AR-10 Automatic Weapon] by V. Bobkowski. Report No. 2-57, dated January 4, 1957.

Colt's Inc., Hartford, Ct.

Ballistic Performance of an Improved Long-Range 5.56mm Bullet (Colt's Design GX-6235), undated.

Chamber and Gas Port Pressures by F. E. Sturtevant, dated April 17, 1964.

Company Confidential - 1966 SPIW Weapons by Robert E. Roy, dated November 2, 1966.

Effect of Ammunition Variables on Acceptance testing of XM16E1 Rifles by William C. Davis, dated November 8, 1965.

Modification Kit for Two and Three Round Burst Control, undated.

Test of 5.56mm Plastic Training Cartridges from Dynamit-Nobel-Genschow by William C. Davis, dated September 30, 1965.

Military Weapons Division:

Introduction to Colt's Military Weapons [M16 Rifle, Carbine, Commando Submachine Gun and CMG-2 Light Machine Gun]; undated.

Light Machine Gun 5.56mm CMG-2, undated.

Entwicklungsanstalt Mauser-IWK, Germany

Cartridge Cal. 5,56x45, an IWK Development by L. Six, dated January 23, 1967.

Fabrique Nationale Herstal, Belgium

Improved Ammunition 5,56x45. FN Report No. TW7, dated October, 1980.

Fairchild Engine and Airplane Corporation, Hagerstown, Md.

The ArmaLite Weapons System by William G. Key, undated (circa 1956).

Franklin Institute Research Laboratories, Philadelphia, Pa.

Proceedings of the 7th Symposium on Explosives and Pyrotechnics. September 8-9, 1971.

General Electric Company

Armament Department, Burlington, Vt.:

Proposal for Development of a Special Purpose Individual Weapon. MPB-618(50)270 February 24, 1970.

Chemical Materials Department, Pittsfield, Ma.:

Concept and Feasibility Study for a Disposable Magazine with XM16E1, 5.56mm Rifle, dated November 30, 1966.

Mellonics Systems Development, Fort Benning, Ga.

The M16A2 Rifle. Memorandum for Record dated December 15, 1982.

Olin Industries Arms and Ammunition Division, New Haven, Ct.

Summary and Recommendations - Multiple Flechette Weapon System Development Contract. Contract No. DAAF03-70-C-0012 dated October 26, 1970 (revised February 1, 1971).

Olin Mathieson Chemical Corporation, Winchester-Western Division, New Haven, Ct.

Winchester Light Weight Military Rifle Caliber .224, dated May 1, 1958.

Operations Research Office (ORO), Johns Hopkins University

Operational Requirements for an Infantry Hand Weapon by Norman A. Hitchman. Report No. ORO T-160 dated June 19, 1952.

Optimum Duplex Spread. Staff Paper No. ORO-SP-4, dated June, 1959.

Optimum Dispersion for Gaussian Salvo. Staff Paper No. ORO-SP-24, dated June, 1959.

Phrobis III Ltd., Oceanside, Ca.

Multi Purpose Bayonet System (MPBS), M9. Operator's Manual, undated.

Sionics, Atlanta, Ga.

Noise and Flash Suppressor Assembly MAW-1 for Use with Rifle, 5.56mm, M16A1. Unsolicited Proposal No. S4-100, undated.

Technik, Incorporated, Jericho, N.Y.

Feasibility Study of Flechette Fired from Rifled Barrel. TR No. 71-1 (for Frankford Arsenal), dated February, 1971.

Patents

Pertinent Patents are described as fully as space permits in the text. Any further research enquiries should be addressed to:

US Department of Commerce
Patent and Trademark Office
Washington, D. C. 20231
USA

[Effective October 5, 1985] the fee for a US Patent reprint (by number) is US $1.50.

Some Other Interesting Patents from the SCHV/Salvo/SPIW Programs:

No. 2,811,901: *Method and Apparatus for Sabot Removal.* (Irwin R. Barr), November 5, 1957.

No. 2,939,395: *Sabot for High Velocity Projectile.* (Irwin R. Barr), June 7, 1960.

No. 3,123,927: *Combined Support and Chambering Guide for Magazine-Fed Cartridges with Fragile Projectiles [Grenades].* (D. L. Katz), March 10, 1964.

No. 3,146,673: *Means for Indexing Multiprojectile Cartridges Into Firing Alignment in a Multibore Gun.* (Frederick P. Reed), September 1, 1964.

No. 3,148,472: *Subcaliber Projectile and Sabot for High Velocity Firearms.* (E. N. Hegge and J. P. McDonough), September 15, 1964.

No. 3,152,513: *Firing Mechanism with Burst Control.* (R. H. Colby), October 13, 1963.

No. 3,160,063: *Operating Mechanism for SALVO-Type Guns.* (R. F. Magardo and Donald C. Dadmun), December 8, 1964.

No. 3,166,983: *Differential Gas System for Gas-Operated Firearms.* (Albert J. Lizza), January 26, 1965.

No. 3,187,632: *Projectile Dispersion Device for Firearms.* (Earle M. Harvey), June 8, 1965.

Magazines and Periodicals

American Firearms Industry:

"The M16 Will Be Obsolete" by R. A. Lesmeister. November, 1985.

American Rifleman:

"Melvin Johnson and His Rifle" by Robert L. Lamoreaux and Melvin Johnson III. April (part one) and May (part two), 1984.

"New Survival Weapon" [AR-5] by George C. Sullivan. January, 1957.

"The .223 Rem." by Finn Aagaard. December, 1985.

Armed Forces Journal:

"The Army's Small Arms Systems Agency [USASASA]" by James D. Hessman and Joseph Volz. November, 1969.

Army Times:

"Light Rifle Offered for Army Test" [AR-10A]. October 20, 1956.

Cibles:

"L'historique du M16" by Jean Huon. February, 1986.

Defense Attache:

"SAR 80: Singapore's Assault Rifle" by Irvine Cohen. Vol. 2, 1982.

Gun Digest:

"The M16A2: New World Standard for Infantry Rifles" by C. E. Harris. 1986.

Guns Magazine:

"Is This the Next G. I. Rifle?" [AR-10] by Eugene Jaderquist. March, 1957.

Gun World:

"AR-16: A Note to NATO" by Jack Lewis. September, 1962.

"Futuristic Firearms for Tomorrow's Infantry" by Bob Zwirtz. Undated, circa 1969.

Infantry:

"The M16 Rifle - Bad Reputation, Good performance" by Art Osborne. Sept-Oct, 1981.

"The Rifle Squad's Artillery" by Maj. Charles R. Baker. Sept-Oct, 1969.

"Rifle Marksmanship" by Lt. Col. Barney K. Neal, Jr., and Capt. St. Elmo P. Tyner II. Sept-Oct, 1969.

International Defense Review:

"NATO Evaluation of Small Arms - Ammunition and Weapons for the Post-1980 Period" by Edward C. Ezell. August, 1979.

National Defense:

"Army Tests Candidate Sniper Rifles" by L. F. Moore. Nov-Dec, 1979.

Ordnance:

"A New Automatic Rifle" [AR-10] by Melvin M. Johnson, Jr. May-June, 1957.

"The Black Rifle" by Col. Rex D. Wing. Mar-Apr, 1971.

The Rifle Magazine:

"A Different History of the .222 Mag." by Edward C. Ezell, Ph.D. Mar-Apr, 1970.

"SPIW: Origin and Development of the Army's Undelivered Super Rifle" by Edward C. Ezell. Mar-Apr, 1969.

"SPIW: A New History" by Irwin R. Barr. 1969.

Shooting Times:

"First Report: The Army's SPIW Ammo" by Frederick Earl Cameron (Robert E. Roy). August, 1969.

Soldier of Fortune:

"Army Wants M16A3" by Peter G. Kokalis. January, 1985.

"Made in Taiwan" [the T65 Rifle] by Peter G. Kokalis. August, 1984.